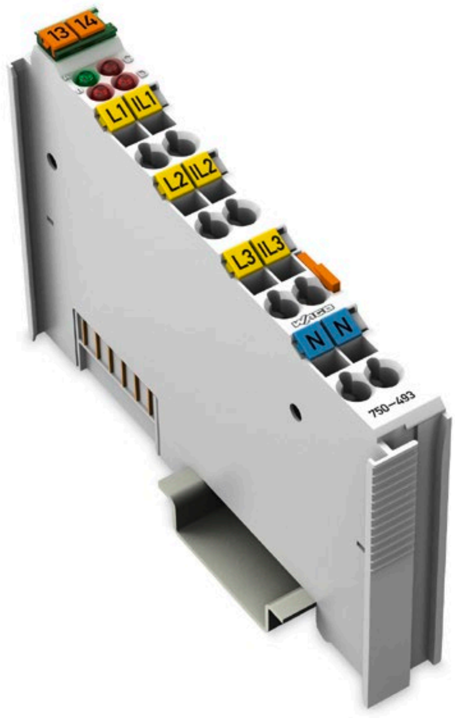
WAGO-I/O-SYSTEM 750

Manual



750-493(/xxx-xxx)

3-Phase Power Measurement Module

Version 1.2.0

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Every conceivable measure has been taken to ensure the accuracy and completeness of this documentation. However, as errors can never be fully excluded, we always appreciate any information or suggestions for improving the documentation.

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1 Notes about this Documentation

Note

Always retain this documentation!
This documentation is part of the product. Therefore, retain the documentation during the entire service life of the product. Pass on the documentation to any subsequent user. In addition, ensure that any supplement to this documentation is included, if necessary.

1.1 Validity of this Documentation

This documentation is only applicable to the I/O module 750-493 (3-Phase Power Measurement Module) and the variants listed in the table below.

Table 1: Variants

Item Number	Description
750-493	3-Phase Power Measurement Module 1 A
750-493/000-001	3-Phase Power Measurement Module 5 A
750-493/025-000	3-Phase Power Measurement Module 1 A, Operating temperature -20 °C … +60 °C
750-493/025-001	3-Phase Power Measurement Module 5A, Operating temperature -20 °C … +60 °C

Note

Documentation Validity for Variants
Unless otherwise indicated, the information given in this documentation applies to listed variants.

The I/O module 750-493 shall only be installed and operated according to the instructions in this manual and in the manual for the used fieldbus coupler/controller.

NOTICE

Consider power layout of the WAGO-I/O-SYSTEM 750!
In addition to these operating instructions, you will also need the manual for the used fieldbus coupler/controller, which can be downloaded at www.wago.com. There, you can obtain important information including information on electrical isolation, system power and supply specifications.

1.2 Revision History

Table 2: Revision History

Document Version	Device Version		Description of Change
	Hardware	Software	
1.0.1	–	–	First issue
1.1.0	≥ 20	≥ 01	Total revision with new layout
1.2.0	≥ 20	≥ 01	Variants 750-493/025-000 and 750-493/025-001 for extended temperature range added.

1.3 Copyright

1.4 Symbols

DANGER

Personal Injury!
Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

DANGER

Personal Injury Caused by Electric Current!
Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Personal Injury!
Indicates a moderate-risk, potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Personal Injury!
Indicates a low-risk, potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Damage to Property!
Indicates a potentially hazardous situation which, if not avoided, may result in damage to property.

NOTICE

Damage to Property Caused by Electrostatic Discharge (ESD)!
Indicates a potentially hazardous situation which, if not avoided, may result in damage to property.

Note

Important Note!
Indicates a potential malfunction which, if not avoided, however, will not result in damage to property.

Information

Additional Information:
Refers to additional information which is not an integral part of this documentation (e.g., the Internet).

1.5 Number Notation

Table 3: Number Notation

Number Code	Example	Note
Decimal	100	Normal notation
Hexadecimal	0x64	C notation
Binary	'100' '0110.0100'	In quotation marks, nibble separated with dots (.)

1.6 Font Conventions

Table 4: Font Conventions

Font Type	Indicates
italic	Names of paths and data files are marked in italic-type. e.g.: *C:\Program Files\WAGO Software*
Menu	Menu items are marked in bold letters. e.g.: **Save**
>	A greater-than sign between two names means the selection of a menu item from a menu. e.g.: **File** > **New**
Input	Designation of input or optional fields are marked in bold letters, e.g.: **Start of measurement range**
“Value”	Input or selective values are marked in inverted commas. e.g.: Enter the value “4 mA” under **Start of measurement range**.
[Button]	Pushbuttons in dialog boxes are marked with bold letters in square brackets. e.g.: **[Input]**
[Key]	Keys are marked with bold letters in square brackets. e.g.: **[F5]**

2 Important Notes

This section includes an overall summary of the most important safety requirements and notes that are mentioned in each individual section. To protect your health and prevent damage to devices as well, it is imperative to read and carefully follow the safety guidelines.

2.1 Legal Bases

2.1.1 Subject to Changes

WAGO Kontakttechnik GmbH & Co. KG reserves the right to provide for any alterations or modifications that serve to increase the efficiency of technical progress. WAGO Kontakttechnik GmbH & Co. KG owns all rights arising from the granting of patents or from the legal protection of utility patents. Third-party products are always mentioned without any reference to patent rights. Thus, the existence of such rights cannot be excluded.

2.1.2 Personnel Qualifications

All sequences implemented on WAGO-I/O-SYSTEM 750 devices may only be carried out by electrical specialists with sufficient knowledge in automation. The specialists must be familiar with the current norms and guidelines for the devices and automated environments.

All changes to the coupler or controller should always be carried out by qualified personnel with sufficient skills in PLC programming.

2.1.3 Use of the WAGO-I/O-SYSTEM 750 in Compliance with Underlying Provisions

Fieldbus couplers, fieldbus controllers and I/O modules found in the modular WAGO-I/O-SYSTEM 750 receive digital and analog signals from sensors and transmit them to actuators or higher-level control systems. Using programmable controllers, the signals can also be (pre-) processed.

The devices have been developed for use in an environment that meets the IP20 protection class criteria. Protection against finger injury and solid impurities up to 12.5 mm diameter is assured; protection against water damage is not ensured. Unless otherwise specified, operation of the devices in wet and dusty environments is prohibited.

Operating the WAGO-I/O-SYSTEM 750 devices in home applications without further measures is only permitted if they meet the emission limits (emissions of interference) according to EN 61000-6-3. You will find the relevant information in the section “Device Description” > “Standards and Guidelines” in the manual for the used fieldbus coupler/controller.

Appropriate housing (per 94/9/EG) is required when operating the WAGO-I/O-SYSTEM 750 in hazardous environments. Please note that a prototype test certificate must be obtained that confirms the correct installation of the system in a housing or switch cabinet.

2.1.4 Technical Condition of Specified Devices

The devices to be supplied ex works are equipped with hardware and software configurations, which meet the individual application requirements. WAGO Kontakttechnik GmbH & Co. KG will be exempted from any liability in case of changes in hardware or software as well as to non-compliant usage of devices.

Please send your request for modified and new hardware or software configurations directly to WAGO Kontakttechnik GmbH & Co. KG.

2.2 Safety Advice (Precautions)

For installing and operating purposes of the relevant device to your system the following safety precautions shall be observed:

DANGER

Install protection against electric shock!
All wiring for the measurement system shall be provided with protection against shock hazard voltages along with the corresponding safety signs!

DANGER

Do not work on devices while energized!
All power sources to the device shall be switched off prior to performing any installation, repair or maintenance work.

DANGER

Install the device only in appropriate housings, cabinets or in electrical operation rooms!
The WAGO-I/O-SYSTEM 750 and its components are an open system. As such, install the system and its components exclusively in appropriate housings, cabinets or in electrical operation rooms. Allow access to such equipment and fixtures to authorized, qualified staff only by means of specific keys or tools.

NOTICE

Note the max. continuous measuring current of 1 A resp. 5 A!
The max. continuous measuring current of the module is 1 A resp. 5 A. If the used current transformers allow greater secondary currents than 1 A resp. 5 A install additional transformers with an appropriate transforming ratio!

NOTICE

Replace defective or damaged devices!
Replace defective or damaged device/module (e.g., in the event of deformed contacts), since the long-term functionality of device/module involved can no longer be ensured.

NOTICE

Protect the components against materials having seeping and insulating properties!
The components are not resistant to materials having seeping and insulating properties such as: aerosols, silicones and triglycerides (found in some hand creams). If you cannot exclude that such materials will appear in the component environment, then install the components in an enclosure being resistant to the above-mentioned materials. Clean tools and materials are imperative for handling devices/modules.

NOTICE

Clean only with permitted materials!
Clean soiled contacts using oil-free compressed air or with ethyl alcohol and leather cloths.

NOTICE

Do not use any contact spray!
Do not use any contact spray. The spray may impair contact area functionality in connection with contamination.

NOTICE

Do not reverse the polarity of connection lines!
Avoid reverse polarity of data and power supply lines, as this may damage the devices involved.

NOTICE

Avoid electrostatic discharge!
The devices are equipped with electronic components that may be destroyed by electrostatic discharge when touched. Please observe the safety precautions against electrostatic discharge per DIN EN 61340-5-1/-3. When handling the devices, please ensure that environmental factors (personnel, work space and packaging) are properly grounded.

3 Device Description

The 3-phase power measurement module (also called I/O module) measures the electrical data in a 3-phase supply network.
The voltages of the three phases are measured via network connection to L1, L2, L3 and N. The currents are fed to IL1, IL2, IL3 and IN via current transformers. The µC unit of the I/O module transmits the RMS (root mean square) values into the process image. Therefore, no high computing power is required from the controller. For each phase, the active power (P) and the energy consumption (W) are calculated by the I/O module using the root mean square values of all measured voltages (V) and currents (I).
For example, both the apparent power (S) and phase shift angle (phi) can easily be derived from these values.
Thus, the I/O module provides a comprehensive network analysis via the fieldbus. By means of values such as voltage, current, active and apparent power consumption or load condition, the operator can regulate the supply to a drive or machine in the best possible way and protect the installation from damage or failure.

The I/O modules 750-493 and 750-493/025-000 measure currents up to 1 A and the modules 750-493/000-001 and 750-493/025-001 measure up to 5 A.

3.1 View

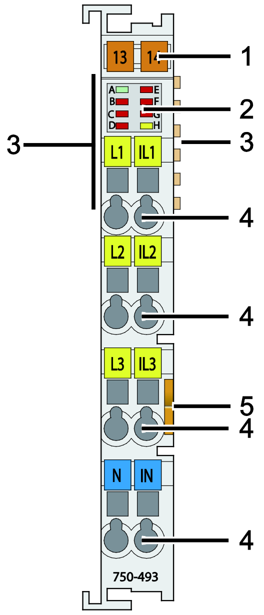


Figure 1: View

Table 5: Legend for Figure "View"

Pos.	Description	Details See Section
1	Marking possibility with Mini-WSB	---
2	Status LEDs	"Device Description" > "Display Elements"
3	Data contacts	"Device Description" > "Connectors"
4	CAGE CLAMP® connectors	"Device Description" > "Connectors"
5	Release tab	"Mounting" > "Inserting and Removing Devices"

3.2 Connectors

3.2.1 Data Contacts/Internal Bus

Communication between the fieldbus coupler/controller and the I/O modules as well as the system supply of the I/O modules is carried out via the internal bus. It is comprised of 6 data contacts, which are available as self-cleaning gold spring contacts.

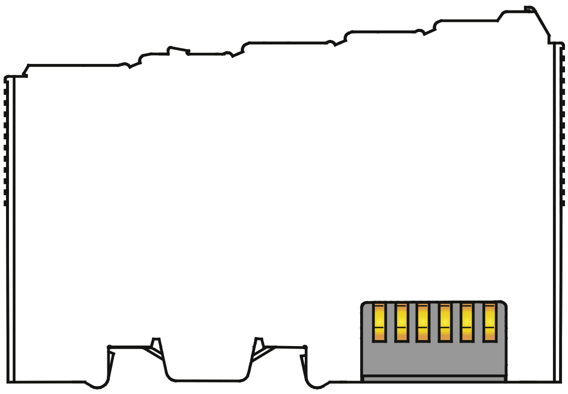


Figure 2: Data Contacts

NOTICE

Do not place the I/O modules on the gold spring contacts!
Do not place the I/O modules on the gold spring contacts in order to avoid soiling or scratching!

NOTICE

Ensure that the environment is well grounded!
The devices are equipped with electronic components that may be destroyed by electrostatic discharge. When handling the devices, ensure that the environment (persons, workplace and packing) is well grounded. Avoid touching conductive components, e.g. data contacts.

3.2.2 Power Jumper Contacts/Field Supply

The I/O module 750-493 has no power jumper contacts.

3.2.3 CAGE CLAMP® Connectors

8 CAGE CLAMP® connectors make up the measuring inputs. The 3-phase supply network and the loads are clamped here. See also section "Connect Devices".

Two connectors each form the three measuring channels:

- L1 and IL1: voltage and current of phase L1
- L2 and IL2: voltage and current of phase L2
- L3 and IL3: voltage and current of phase L3

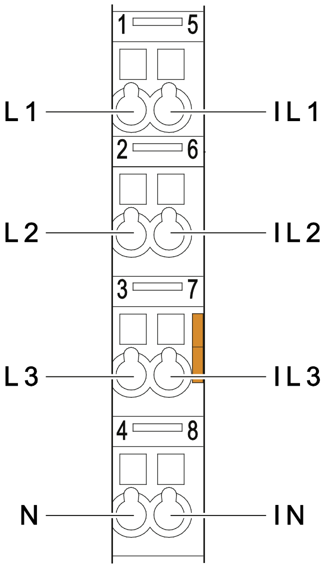


Figure 3: CAGE CLAMP® Connectors

Table 6: Legend for Figure "CAGE CLAMP® Connectors"

Channel	Designation	Connector	Function
1	L1	1	Voltage L1
	IL1	5	Current L1
2	L2	2	Voltage L2
	IL2	6	Current L2
3	L3	3	Voltage L3
	IL3	7	Current L3
–	N	4	Neutral wire for voltage measurement
	IN	8	Neutral wire for current measurement

3.3 Display Elements

8 LEDs A … H are used to indicate the operating status and possible errors. The meaning of these indications is listed in section „Diagnostics“.

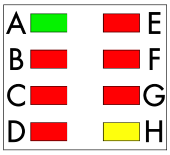


Figure 4: LED-indicators

3.4 Operating Elements

The I/O module 750-493 has no operating elements.

3.5 Schematic Diagram

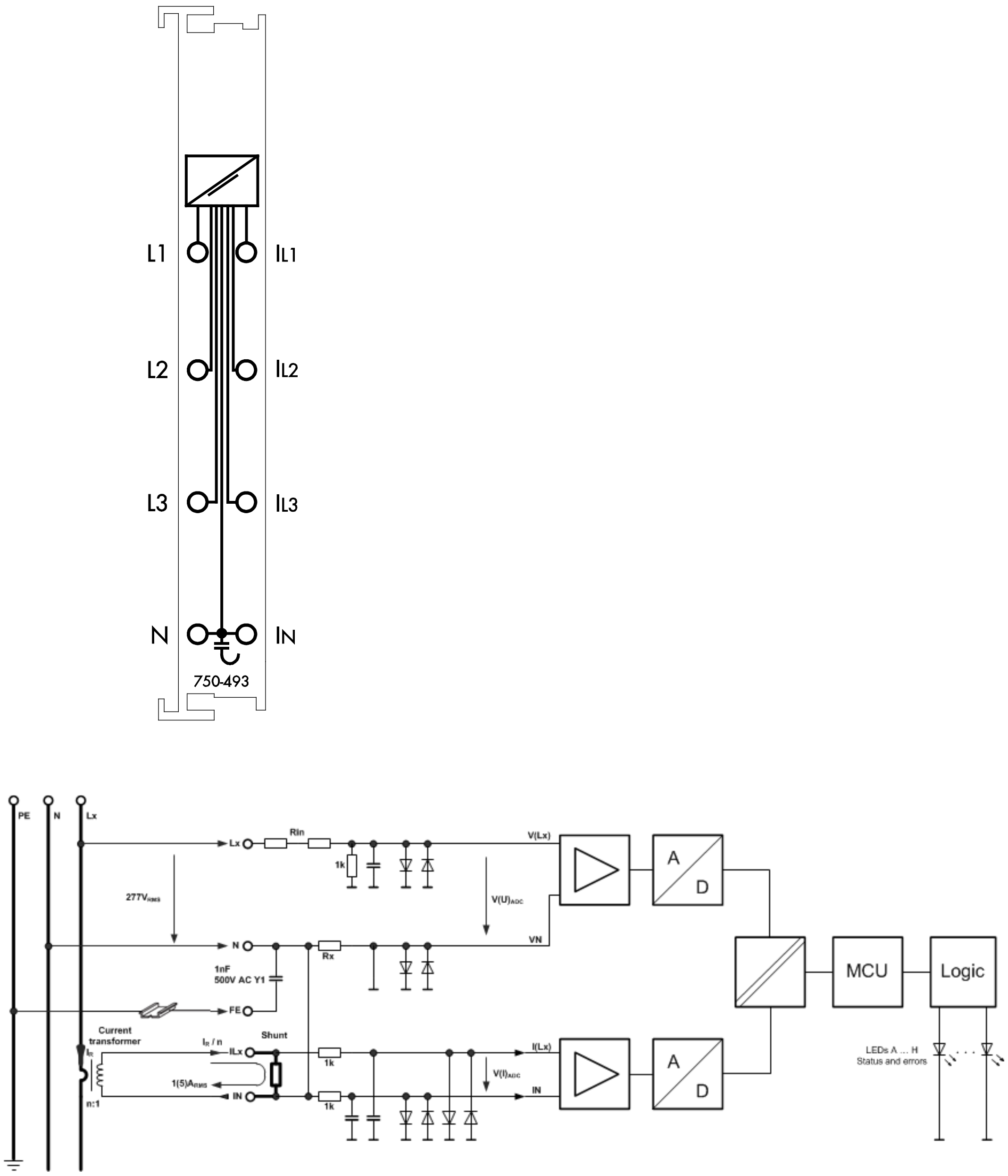


Figure 5: Schematic Diagram

Note

Function Earth FE!
In order to get a function earth, the connections N and IN are connected to the mounting rail via a 1 nF capacitor and a spring contact. If the rail is correctly connected to PE, the immunity to interference is increased.

3.6 Technical Data

3.6.1 Dimensions and Weight

Table 7: Technical Data – Dimensions and Weight

Width	12 mm
Height (from upper edge of carrier rail)	64 mm
Length	100 mm
Weight	48 g

3.6.2 Voltage Supply

Table 8: Technical Data – Voltage Supply

Voltage	System voltage DC 5 V (via internal bus)
Current consumption	100 mA
Category of overvoltage	III
Rated voltage impulse	4 kV
Degree of distortion	2

3.6.3 Measuring Inputs

Table 9: Technical Data – Measuring Inputs

Number of inputs	6 (3 voltage inputs, 3 current inputs)
Rated measuring voltage max. Input resistance typ.	Phase-to-phase voltage Lx - Ly: 480 VAC Phase voltage Lx - N: 277 VAC/DC 1072 kΩ
Measuring current max. Input resistance typ.	1 A for 750-493, 5 A for 750-493/000-001 1 A for 750-493,025-000 5 A for 750-493/025-001 22 mΩ for 750-493, 5 mΩ for 750-493/000-001 22 mΩ for 750-493/025-000 5 mΩ for 750-493/025-001
Frequency range - DC filter activated - DC filter deactivated	 10 … 2000 Hz 0 … 2000 Hz
Max. frequency	7.2 kHz
Signal form	any (in consideration of the frequency range and max. frequency)

3.6.4 Measuring Signal Processing

Table 10: Technical Data – Measuring Signal Processing

Measuring procedure	Calculation of true RMS for voltages and currents, sample rate 8 kHz per channel, resolution 24 bits
Measuring cycle time	Configurable for min. and max. values
Measuring error for current and voltage	For AC max. 0.5 %, for DC max. 1.0 % (of full-scale value)
Calculated values	Active power and energy, network frequency and cos phi

3.6.5 Internal Bus Communication

Table 11: Technical Data – Internal Bus Communication

Bit width (internal bus)	Input and output data with 9 bytes each

3.6.6 Connection Type

Table 12: Technical Data – Data Contacts

Data contacts	Slide contact, hard gold plated, self-cleaning

Table 13: Technical Data – Field Wiring

Wire connection	CAGE CLAMP®
Cross section	0.08 mm² … 2.5 mm², AWG 28 … 14
Stripped lengths	8 mm … 9 mm / 0.33 in

3.6.7 Climatic Environmental Conditions

Table 14: Technical Data – Climatic Environmental Conditions

Operating temperature range	0 °C … 55 °C
Operating temperature range for components with extended temperature range (750-xxx/025-xxx)	−20 °C … +60 °C
Storage temperature range	−25 °C … +85 °C
Storage temperature range for components with extended temperature range (750-xxx/025-xxx)	−40 °C … +85 °C
Relative humidity	Max. 5 % … 95 % without condensation
Resistance to harmful substances	Acc. to IEC 60068-2-42 and IEC 60068-2-43
Maximum pollutant concentration at relative humidity < 75 %	$SO_2 \leq 25$ ppm $H_2S \leq 10$ ppm
Special conditions	Ensure that additional measures for components are taken, which are used in an environment involving: – dust, caustic vapors or gases – ionizing radiation

3.7 Approvals

The following approvals have been granted to the basic version and all variants of 750-493 I/O modules:

Conformity Marking

$_{C}$UL$_{US}$ UL508

The following approvals have been granted to the basic version of 750-493 I/O modules and the variation 750-493/000-001:

Korea Certification MSIP-REM-W43-AIM750

The following Ex approvals have been granted to the basic version and all variants of 750-493 I/O modules:

TÜV 07 ATEX 554086 X

I M2 Ex d I Mb
II 3 G Ex nA IIC T4 Gc
II 3 D Ex tc IIIC T135°C Dc

IECEx TUN 09.0001 X

Ex d I Mb
Ex nA IIC T4 Gc
Ex tc IIIC T135°C Dc

$_{C}$UL$_{US}$ ANSI/ISA 12.12.01
Class I, Div2 ABCD T4

3.8 Standards and Guidelines

750-493 I/O modules meet the following standards and guidelines:

Explosive atmosphere Devices – General requirements	EN 60079-0
Explosive atmosphere Equipment protection by type of protection "n"	EN 60079-15
Explosive atmosphere Equipment dust ignition protection by enclosure "t"	EN 60079-31
EMC CE-Immunity to interference	acc. to EN 61000-6-2
EMC CE-Emission of interference	acc. to EN 61000-6-4

4 Process Image

The 750-493 I/O module provides, on 3 logical channels, a maximum of 9 bytes input and 9 bytes output process data to a fieldbus coupler/controller. The data to be sent and received will be stored in up to 6 input and output bytes (D0 ... D5), i.e. in 3 data words. This means 3 process data are sent.
3 control bytes (C0 ... C2) and 3 status bytes (S0 … S2) are used for selecting process data and for setting parameters.

NOTICE

Notice that the process data image depends on the used fieldbus coupler/ controller!
Mapping the process data into the process image is specific for the fieldbus coupler/controller used. You will find both this information and the specific configuration of the relevant control/status bytes in the manual of the coupler/controller, section "Fieldbus Specific Configuration of Process Data" which describes the process image.

4.1 Input and Output Data

Table 15: Input and Output Data

9 Bytes Input Data		9 Bytes Output Data	
S0	Status byte 0	C0	Control byte 0
D0	Input data word 1 (LSB)	D0	Output data word 1 (LSB)
D1	Input data word 1 (MSB)	D1	Output data word 1 (MSB)
S1	Status byte 1	C1	Control byte 1
D2	Input data word 2 (LSB)	D2	Output data word 2 (LSB)
D3	Input data word 2 (MSB)	D3	Output data word 2 (MSB)
S2	Status byte 2	C2	Control byte 2
D4	Input data word 3 (LSB)	D4	Output data word 3 (LSB)
D5	Input data word 3 (MSB)	D5	Output data word 3 (MSB)

4.2 Simple Process Image

Each input data word in a simple process image is assigned to one channel and can only read measured values from this channel.

Table 16: Simple Process Image

	Controlbyte	Input Data Word	
Channel 1	C0	Input data word 1	
		D1	D0
Channel 2	C1	Input data word 2	
		D3	D2
Channel 3	C2	Input data word 3	
		D5	D4

When entering a process data index into a control byte in the process data mode, the process data is returned in the associated process data word.

The process data indices are listed below in section "Control and Status Bytes".

The channel index has no significance in the simple process image.

The simple process image is the default (factory) setting.

1st Example:
Reading out the voltages (rms value) of phases L1, L2 and L3

Enter 0x01 (process data index = 1) into the control bytes C0, C1 and C2.

The voltage (rms value) of phase L1 is returned in process data word 1 (D0, D1), the voltage (rms value) of phase L2 is returned in process data word 2 (D2, D3) and the voltage (rms value) of phase L3 is returned in process data word 3 (D4, D5).

2nd Example:
Reading out the voltage (rms value) of phase L1, the current (rms value) of phase L2 and the active power of phase L3

Enter 0x01 (channel index = 0, process data index = 1) into control byte C0,
0x00 (channel index = 0, process data index = 0) into control byte C1 and
0x02 (channel index = 0, process data index = 2) into control byte C2.

The voltage (rms value) of phase L1 is returned in input data word 1 (D0, D1), the current (rms value) of phase L2 is returned in input data word 2 (D2, D3) and the active power of phase L3 is returned in input data word 3 (D4, D5).

4.3 Flexible Process Image

An input data word in a flexible process image can read measured values from any channel.

The flexible process image is enabled via WAGO-I/O-*CHECK* on the „Phase L1“, „Phase L2“ and „Phase L3“ tabs.

1st Example:
Reading out the current (rms value), voltage (rms value) and active power of phase L2

Enter 0x10 (channel index 1, process data index 0) into control byte C0,
0x11 (channel index 1, process data index 1) into control byte C1 and
0x12 (channel index 1, process data index 2) into control byte C2.

The current (rms value) of phase L2 is returned in input data word 1 (D0, D1), the voltage (rms value) of phase L2 is returned in input data word 2 (D2, D3) and the active power of phase L2 is returned in input data word 3 (D4, D5).

2nd Example:
Reading out the current (rms value) and voltage (rms value) of phase L1 and the voltage (rms value) of phase L2

Enter 0x00 (channel index 0, process data index 0) into control byte C0,
0x01 (channel index 0, process data index 1) into control byte C1 and
0x11 (channel index 1, process data index 1) into control byte C2.

The current (rms value) of phase L1 is returned in input data word 1 (D0, D1), the voltage (rms value) of phase L1 is returned in input data word 2 (D2, D3) and the voltage (rms value) of phase L2 is returned in input data word 3 (D4, D5).

4.4 Control and Status Bytes

Table 17: Control Byte C0

Control Byte C0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reg_Com	Reserved	Channel_ID		ProcDat_ID			

ProcDat_ ID	Here, enter the process data index for the physical variable you wish to read out using input data word 1.		
	0:	Current (rms)	
	1:	Voltage (rms)	
	2:	Active power	
	3:	Power factor	
	4:	Active energy	
	5:	Max. current	
	6:	Max. voltage	
	7:	Max. active power	
	8:	Frequency	
	9:	Min. current	
	10:	Min. voltage	
	11:	Min. active power	
	12 .... 15:	Reserved	
Channel_ ID	Simple process image	Always 0 (With the simple process image the channel index has no significance.)	
	Flexible process image	Here, enter the channel index for the channel from which you wish to read out a measured value using input data word 1.	
		0:	Channel 1
		1:	Channel 2
		2:	Channel 3
		3:	Calibration mode active
Reg_Com	0:	Process data communication	
	1:	Register communication	

Table 18: Status Byte S0

Status Byte S0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reg_Com	Err_L1	Channel_ID		ProcDat_ID			

ProcDat_ ID	Process data index for the physical variable which was read out using input data word 1.	
Channel_ ID	Simple process image	Always 0 (With the simple process image the channel index has no significance.)
	Flexible process image	Channel index for the channel from which a measured value was read out using input data word 1
Err_L1	0:	The voltage between L1 and N is greater than the set undervoltage threshold.
	1:	The voltage between L1 and N is less than the set undervoltage threshold. The LED „B“ lights up.
Reg_Com	0:	Process data communication
	1:	Register communication

Table 19: Control Byte C1

Control Byte C1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reg_Com	Reserved	Channel_ID		ProcDat_ID			

ProcDat_ ID	Here, enter the process data index for the physical variable you wish to read out using input data word 2.		
	0:	Current (rms)	
	1:	Voltage (rms)	
	2:	Active power	
	3:	Power factor	
	4:	Active energy	
	5:	Max. current	
	6:	Max. voltage	
	7:	Max. active power	
	8:	Frequency	
	9:	Min. current	
	10:	Min. voltage	
	11:	Min. active power	
	12 .... 15:	Reserved	
Channel_ ID	Simple process image	Always 0 (With the simple process image the channel index has no significance.)	
	Flexible process image	Here, enter the channel index for the channel from which you wish to read out a measured value using input data word 2.	
		0:	Channel 1
		1:	Channel 2
		2:	Channel 3
		3:	Calibration mode active
Reg_Com	0:	Process data communication	
	1:	Register communication	

Table 20: Status Byte S1

Status Byte S1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reg_Com	Err_L2	Channel_ID		ProcDat_ID			

ProcDat_ ID	Process data index for the physical variable which was read out using input data word 2.	
Channel_ ID	Simple process image	Always 0 (With the simple process image the channel index has no significance.)
	Flexible process image	Channel index for the channel from which a measured value was read out using input data word 2
Err_L2	0:	The voltage between L2 and N is greater than the set undervoltage threshold.
	1:	The voltage between L2 and N is less than the set undervoltage threshold. The LED „E“ lights up.
Reg_Com	0:	Process data communication
	1:	Register communication

Table 21: Control Byte C2

Control Byte C2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reg_Com	Reserved	Channel_ID		ProcDat_ID			

ProcDat_ ID	Here, enter the process data index for the physical variable you wish to read out using input data word 3.		
	0:	Current (rms)	
	1:	Voltage (rms)	
	2:	Active power	
	3:	Power factor	
	4:	Active energy	
	5:	Max. current	
	6:	Max. voltage	
	7:	Max. active power	
	8:	Frequency	
	9:	Min. current	
	10:	Min. voltage	
	11:	Min. active power	
	12 .... 15:	Reserved	
Channel_ ID	Simple process image	Always 0 (With the simple process image the channel index has no significance.)	
	Flexible process image	Here, enter the channel index for the channel from which you wish to read out a measured value using input data word 3.	
		0:	Channel 1
		1:	Channel 2
		2:	Channel 3
		3:	Calibration mode active
Reg_Com	0:	Process data communication	
	1:	Register communication	

Table 22: Status Byte S2

<table>
<tr><th colspan="8">Status Byte S2</th></tr>
<tr><td>Bit 7</td><td>Bit 6</td><td>Bit 5</td><td>Bit 4</td><td>Bit 3</td><td>Bit 2</td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td>Reg_Com</td><td>Err_L3</td><td colspan="2">Channel_ID</td><td colspan="4">ProcDat_ID</td></tr>
<tr><td>ProcDat_ ID</td><td colspan="7">Process data index for the physical variable which was read out using input data word 3.</td></tr>
<tr><td rowspan="2">Channel_ ID</td><td>Simple process image</td><td colspan="6">Always 0
(With the simple process image the channel index has no significance.)</td></tr>
<tr><td>Flexible process image</td><td colspan="6">Channel index for the channel from which a measured value was read out using input data word 3</td></tr>
<tr><td rowspan="2">Err_L3</td><td>0:</td><td colspan="6">The voltage between L3 and N is greater than the set undervoltage threshold.</td></tr>
<tr><td>1:</td><td colspan="6">The voltage between L3 and N is less than the set undervoltage threshold. The LED „F“ lights up.</td></tr>
<tr><td rowspan="2">Reg_Com</td><td>0:</td><td colspan="6">Process data communication</td></tr>
<tr><td>1:</td><td colspan="6">Register communication</td></tr>
</table>

5 Function Description

5.1 Measuring Principle

The 3-phase power measurement module operates using 6 analog/digital converters for acquiring the current and voltage levels in all three phases. The 3 phases are connected to the current measuring channels of the I/O module in "single-ended" measurement topology. Each of the 6 measurement inputs is scanned at a frequency of 8 kHz. The input filters on the measuring channels have a limit frequency of 7.2 kHz. The analog measured values are quantized with 24 bits and further processed digitally.
Acquisition and processing of the measured values of all three phases is performed simultaneously in the very same way.

5.2 Measured Values and Measured Value Calculation

The 3-phase power measurement module makes the following **AC measured values** available per phase (Lx = L1, L2 or L3):

Voltage:	•	RMS value voltage Lx – N
	•	Maximum RMS value voltage Lx – N
	•	Minimum RMS value voltage Lx – N
Current:	•	RMS value current Lx
	•	Maximum RMS value current Lx
	•	Minimum RMS value current Lx
Power:	•	Active power Lx
	•	Maximum value active power Lx
	•	Minimum value active power Lx
Energy:	•	Active energy Lx
Frequency:	•	Supply network frequency Lx
Power factor:	•	cos phi Lx
Limit value:	•	Undervoltage Lx: Threshold value undershot

Alternatively, the following **DC measured values** are available if DC measurement has been activated in the I/O module. See section "Commissioning" > "Configuration with WAGO-I/O-*CHECK*".

Voltage:	•	DC voltage Lx – N
Current:	•	DC current Lx
Power:	•	Power (DC current) Lx

Calculating the RMS Values for Current and Voltage

The I/O module measures the true RMS of the voltages and currents applied to the measurement inputs per period. See figure below.

$$I_{eff} = \sqrt{\frac{1}{N}\sum_{k=0}^{N-1} i_k^{\,2}} \qquad U_{eff} = \sqrt{\frac{1}{N}\sum_{k=0}^{N-1} u_k^{\,2}}$$

i_k:	Scan value of the current	I_{eff}:	RMS value of the current
u_k:	Scan value of the voltage	U_{eff}:	RMS value of the voltage
N:	No. of scan values		

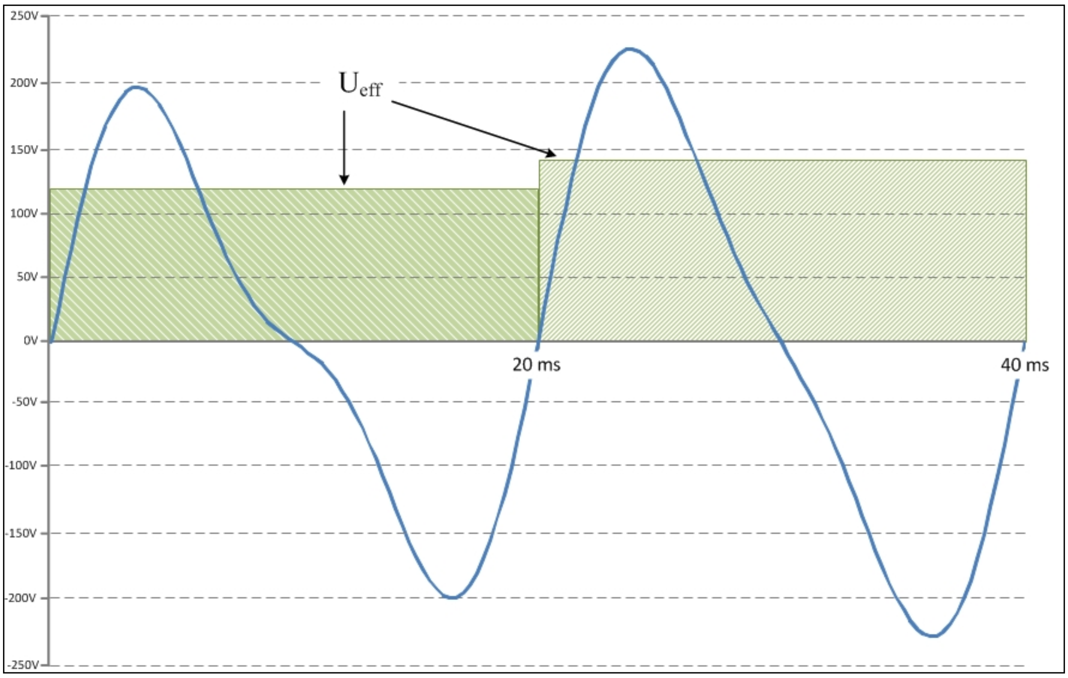


Figure 6: RMS Value Calculation (Example, Not to Scale)

In a 50-Hz-supply network, the RMS value can be read with the specified measuring accuracy with every second period via the process image. Therefore, the default setting of the measuring cycle time is 39 ms.

For applications where voltage and current drops have to be evened out, a mean of the RMS values for current and voltage can be generated by the measuring cycle time setting. If a time of 40 ms is set in WAGO-I/O-*CHECK*, there is averaging of 2 RMS values, a value of 500 ms is set, there is averaging of 13 RMS values (500/39 = 12.82).

The maximum measuring cycle time can be 24375 ms. The update rate in the process image corresponds to the time set.

Calculating Power and Energy

The individual time-synchronous scan values for currents and voltages are used to calculate active power (P). Phase shifts between currents and voltages are taken into account when calculating power.
The time integration of power yields the energy per phase.

Determining the Frequency

Phase frequencies are determined by zero-crossing detection of the scanned signals.

Calculating the Power Factor cos phi

The power factor cos phi is calculated from the phase shift between current and voltage of the fundamental wave of the respective phase.

The I/O module can be configured, so that the cos phi is output with or without sign (see section "Commissioning" > "Configuration with WAGO-I/O-*CHECK*"). If a sign is put out, it is **not** the information acquisition (+) or delivery (-) of active power (P), but a statement on the load on the network:

- A positive (+) sign of the cos phi means **inductive load**
- A negative (-) sign of the cos phi means **capacitive load**

Together with the sign of the active power, you can determine the quadrants in the 4-quadrant display for an AC network:

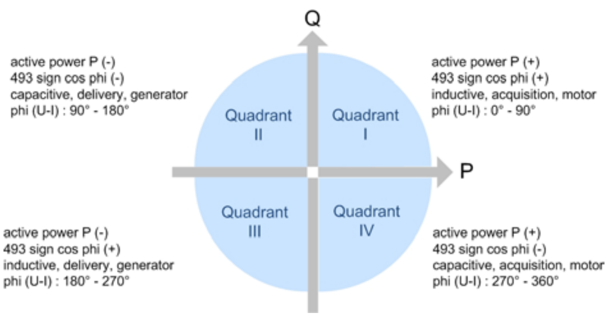


Figure 7: 4-Quadrant Display of Active and Reactive Power

Apparent Power and Reactive Power

Not all loads are purely resistive in real supply networks. Phase shifting therefore occurs between the current and the voltage. However, this does not affect the method for determining the RMS values for current and voltage previously described. They can both be obtained as measured values from the I/O module.

The apparent power (S) can be calculated from these measured values using the following equation:

$$S = U \cdot I$$

The reactive power (Q) can then be calculated using the following equation:

$$Q = \sqrt{S^2 - P^2}$$

5.3 Representation of the Measured Values in the Process Image (PI)

The I/O module records and calculates numerous measured values. Up to 3 measured values can be represented in the process image (PI). The selection of these ones is made with the process data indices in control bytes C0, C1 and C2 in the output data.
The following table lists the available measured values:

Table 23: Measured Values in the Process Image (PI)

Measured Value	Data Type PI	Scaling Factor PI	
		750-493 750-493/025-000 (1A)	750-493/000-001 750-493/025-001 (5A)
Voltage			
RMS value voltage L1 - N	UInt16	0.1V / LSB	0.1V / LSB
RMS value voltage L2 - N	UInt16	0.1V / LSB	0.1V / LSB
RMS value voltage L3 - N	UInt16	0.1V / LSB	0.1V / LSB
Maximum RMS value voltage L1 - N	UInt16	0.1V / LSB	0.1V / LSB
Maximum RMS value voltage L2 - N	UInt16	0.1V / LSB	0.1V / LSB
Maximum RMS value voltage L3 - N	UInt16	0.1V / LSB	0.1V / LSB
Minimum RMS value voltage L1 - N	UInt16	0.1V / LSB	0.1V / LSB
Minimum RMS value voltage L2 - N	UInt16	0.1V / LSB	0.1V / LSB
Minimum RMS value voltage L3 - N	UInt16	0.1V / LSB	0.1V / LSB
Current			
RMS value current L1	UInt16	0.001A / LSB	0.005A / LSB
RMS value current L2	UInt16	0.001A / LSB	0.005A / LSB
RMS value current L3	UInt16	0.001A / LSB	0.005A / LSB
Maximum RMS value current L1	UInt16	0.001A / LSB	0.005A / LSB
Maximum RMS value current L2	UInt16	0.001A / LSB	0.005A / LSB
Maximum RMS value current L3	UInt16	0.001A / LSB	0.005A / LSB
Minimum RMS value current L1	UInt16	0.001A / LSB	0.005A / LSB
Minimum RMS value current L2	UInt16	0.001A / LSB	0.005A / LSB
Minimum RMS value current L3	UInt16	0.001A / LSB	0.005A / LSB
Power			
Active power L1	Int16	0.1W / LSB	0.5W / LSB
Active power L2	Int16	0.1W / LSB	0.5W / LSB
Active power L3	Int16	0.1W / LSB	0.5W / LSB
Maximum value active power L1	Int16	0.1W / LSB	0.5W / LSB
Maximum value active power L2	Int16	0.1W / LSB	0.5W / LSB
Maximum value active power L3	Int16	0.1W / LSB	0.5W / LSB
Minimum value active power L1	Int16	0.1W / LSB	0.5W / LSB

Minimum value active power L2	Int16	0.1W / LSB	0.5W / LSB
Minimum value active power L3	Int16	0.1W / LSB	0.5W / LSB

Energy			
Active energy L1	UInt16	Setup with WAGO-I/O-*CHECK* or in Register 35	
Active energy L2	UInt16	Setup with WAGO-I/O-*CHECK* or in Register 35	
Active energy L3	UInt16	Setup with WAGO-I/O-*CHECK* or in Register 35	
Frequency			
Supply network frequency L1	UInt16	0.1Hz / LSB	0.1Hz / LSB
Supply network frequency L2	UInt16	0.1Hz / LSB	0.1Hz / LSB
Supply network frequency L3	UInt16	0.1Hz / LSB	0.1Hz / LSB
Power factor			
cos phi L1	Int16	0.01	0.01
cos phi L2	Int16	0.01	0.01
cos phi L3	Int16	0.01	0.01
DC measured values			
DC voltage L1 - N	UInt16	0.1V / LSB	0.1V / LSB
DC voltage L2 - N	UInt16	0.1V / LSB	0.1V / LSB
DC voltage L3 - N	UInt16	0.1V / LSB	0.1V / LSB
DC current L1	UInt16	0.001A / LSB	0.005A / LSB
DC current L2	UInt16	0.001A / LSB	0.005A / LSB
DC current L3	UInt16	0.001A / LSB	0.005A / LSB
Power (DC current) L1	Int16	0.1W / LSB	0.5W / LSB
Power (DC current) L2	Int16	0.1W / LSB	0.5W / LSB
Power (DC current) L3	Int16	0.1W / LSB	0.5W / LSB

The format of the measured values with sign (Int16) is the two's complement. Generally, use the following equation to calculate the measured values from the process values:

Measured value = Process value x Scaling factor PI

Examples of Calculating the Measured Values

Voltage	750-493	750-493/000-001
Process value	0x07D0 (2000)	0x074A (1866)
Scaling factor PI	0.1 V / LSB	0.1 V / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	200.0 V	186.6 V

Frequency	750-493	750-493/000-001
Process value	0x01F5 (501)	0x0257 (599)
Scaling factor PI	0.1 Hz / LSB	0.1 Hz / LSB
Equation	Measured value = Process value x Scaling factor PI	

Measured value	50.1 Hz	59.9 Hz
cos phi	750-493	750-493/000-001
Process value	0xFFB2 (-78)	0x0059 (89)
Scaling factor PI	0.01 / LSB	0.01 / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	-0.78	0.89

When calculating current-dependent values, the **current transformer ratio (CTR)** must be taken into account when using a current transformer.

Information

Current transformers
Current transformers are available on the market in different designs. On the primary side, currents of 20 A, 25 A, 30 A, 35 A, 40 A, 45 A, 50 A, 75 A, 100 A … 5000 A are supported, on the secondary side 1 A or 5 A.

For example, transformation ratios of 45:1 A (750-493) or 200:5 A (750-493/000-001) are possible. Thus, the corresponding current transformer ratios (CTR) are 1:45 and 1:40.

The I/O module allows you to set **user scaling** using WAGO-I/O-*CHECK* or via Register 32, bit 0. If the bit is set to 0, user scaling is disabled (off) and the transformation ratio of the current is 1:1.
If the bit is set to 1, user scaling is enabled (on) and the transformation ratio is already taken into account in the I/O module. The transformation ratio is set using WAGO-I/O-*CHECK* or in Register 37. The **divisor of the CTR (D-CTR)** is set in the register, i.e. according to the examples above:

- 1A variants: CTR = 1:45, D-CTR = 45 => Register 37
- 5A variants: CTR = 1:40, D-CTR = 40 => Register 37

In the I/O module, the RMS values of the currents are represented in the process image according to the table "Measured values in the process image (PI)" above as UInt16 with the following scaling:

- 1A variants: 0.001 A / LSB
- 5A variants: 0.005 A / LSB

Only the following maximum currents can be represented in the process image and thus only the corresponding maximum CRT values can be supported:

<u>1A variants:</u>
0 ... 65535 at 1 mA/LSB => 0.000 ... 65.535 A
and thus: D-CTR max. = 50, transformation ratios max. = 50:1 A

<u>5A variants:</u>
0 ... 65535 at 5 mA/LSB => 0.000 ... 327.675 A
and thus: D-CTR max. = 50, transformation ratios max. = 250:5 A

The decisive factor is the **maximum** representable current value in the process image.

If the transformation ratio is 500:1 A, for example, the resulting D-CTR of 500 cannot be taken into account in the I/O module 750-493 (1A) directly via active user scaling, likewise a D-CTR of 100 at a transformation ratio of 500:5 A in 750-493/000-001 (5A).

Therefore, the following setting options and calculations for the measured values result in the process image for the current-dependent variables:

A. User Scaling OFF, Measurement without Current Transformer

Current	750-493	750-493/000-001
Register 32, bit 0	0	0
Register 37 (D-CTR)	0x0001 (1)	0x0001 (1)
Process value	0x01A9 (425)	0x033D (829)
Scaling factor PI	0.001 A / LSB	0.005 A / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	0.425 A	4.145 A

Active Power	750-493	750-493/000-001
Register 32, bit 0	0	0
Register 37 (D-CTR)	0x0001 (1)	0x0001 (1)
Process value	0x03D2 (978)	0x0776 (1910)
Scaling factor PI	0.1 W / LSB	0.5 W / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	97.8 W	955.0 W

Active Energy	750-493	750-493/000-001
Register 32, bit 0	0	0
Register 37 (D-CTR)	0x0001 (1)	0x0001 (1)
Register 35*	1	3
Process value	0x22ED (8941)	0 x 1126(4390)
Scaling factor PI	0.01 Wh / LSB	5 Wh / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	89.41 Wh	21950 Wh

* Register 35: Setting in the register defines the scaling factor PI for energy values

B. User Scaling ON, Measurement with Current Transformer

Current	750-493	750-493/000-001
Register 32, bit 0	1	1
Register 37 (D-CTR)	0x002D (45)	0x0028 (40)
Process value	0x96A1 (38561)	0x60FB (24827)
Scaling factor PI	0.001 A / LSB	0.005 A / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	38.561 A	124.135 A

Active Power	750-493	750-493/000-001
Register 32, bit 0	1	1
Register 37 (D-CTR)	0x002D (45)	0x0028 (40)
Process value	0x22A5 (8869)	0x1648 (5704)
Scaling factor PI	0.1 W / LSB	0.5 W / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	886.9 W	2852.0 W

Active Energy	750-493	750-493/000-001
Register 32, bit 0	1	1
Register 37 (D-CTR)	0x002D (45)	0x0028 (40)
Register 35*	2	4
Process value	0x0D86 (3462)	0x2CA3 (11427)
Scaling factor PI	0.1 Wh / LSB	50 Wh / LSB
Equation	Measured value = Process value x Scaling factor PI	
Measured value	346.2 Wh	571350 Wh

* Register 35: Setting in the register defines the scaling factor PI for energy values

C. User Scaling OFF, Measurement with Current Transformer 500:1 A (1A Variants) and 500:5 A (5A Variants)

D-CTR values of 500 or 100 must be taken into account externally when user scaling is OFF, i.e. the transferred measured value must be multiplied by 500 or 100 in the high-level PLC.

Current	750-493	750-493/000-001
Register 32, bit 0	0	0
Register 37 (D-CTR)	0x0001 (1)	0x0001 (1)
Process value	0x01A9 (425)	0x033D (829)
Scaling factor PI	0.001 A / LSB	0.005 A / LSB
Equation	Measured value = Process value x Scaling factor PI x D-CTR	
Measured value	212.5 A	414.5 A

Note: Resolution of the current values in 500mA steps

Active Power	750-493	750-493/000-001
Register 32, bit 0	0	0
Register 37 (D-CTR)	0x0001 (1)	0x0001 (1)
Process value	0x03D2 (978)	0x0776 (1910)
Scaling factor PI	0.1 W / LSB	0.5 W / LSB
Equation	Measured value = Process value x Scaling factor PI x D-CTR	
Measured value	48900 W	95500 W

Active Energy	750-493	750-493/000-001
Register 32, bit 0	0	0
Register 37 (D-CTR)	0x0001 (1)	0x0001 (1)
Register 35*	1	3
Process value	0x22ED (8941)	0 x 1126 (4390)
Scaling factor PI	0.01 Wh / LSB	5 Wh / LSB
Equation	Measured value = Process value x Scaling factor PI x D-CTR	
Measured value	44705 Wh	2195000 Wh

* Register 35: Setting in the register defines the scaling factor PI for energy values

D. User Scaling ON, Measurement with Current Transformer 500:1 A (1A Variants) and 500:5 A (5A Variants)

In this example, the D-CTR is divided into two parts: D-CTR1 is programmed in the I/O module and taken into account with the process value, the other one D-CTR 2 must be taken into account externally, in the high-level PLC, when calculating the measured value:

500:1 A => D-CTR = 500 - D-CTR1 = 50, D-CTR2 = 10
500:5 A => D-CTR = 100 - D-CTR1 = 50, D-CTR2 = 2

Due to the high internal resolution of the current measurement in the I/O module, the process values are available with mA resolution. The resolution and data type of other measured values must be observed, so that the measured values do not exceed the range limits (e.g. for the measured power values).

Current	750-493	750-493/000-001
Register 32, bit 0	1	1
Register 37 (D-CTR1)	0x0032 (50)	0x0032 (50)
Process value	0xA6AF (42671)	0x2103 (8451)
Scaling factor PI	0.001 A / LSB	0.005 A / LSB
Equation	Measured value = Process value x Scaling factor PI x D-CTR2	
Measured value	426.71 A	84.51 A

Note: Resolution of the current values in 10mA steps

Active Power	750-493	750-493/000-001
Register 32, bit 0	1	1
Register 37 (D-CTR1)	0x0032 (50)	0x0032 (50)
Process value	0x5486 (21638)	0xFFFF (65535)
Scaling factor PI	0.1 W / LSB	0.5 W / LSB
Equation	Measured value = Process value x Scaling factor PI x D-CTR2	
Measured value	21638 W	65535 W

Active Energy	750-493	750-493/000-001
Register 32, bit 0	1	1
Register 37 (D-CTR1)	0x0032 (50)	0x0032 (50)
Register 35*	4	5
Process value	0x2CFD (11517)	0x0593 (1427)
Scaling factor PI	10 Wh / LSB	500 Wh / LSB
Equation	Measured value = Process value x Scaling factor PI x D-CTR2	
Measured value	1151700 Wh	1427000 Wh

* Register 35: Setting in the register defines the scaling factor PI for energy values

5.4 Measuring Errors and Accuracy

The measuring errors of the I/O module are specified in the table below. The values already take into account the errors caused by the connection method (single-ended 0.1%) and the calibration tolerance (0.1%). They apply to the entire temperature range of 0 to 55 °C and to frequencies of 45 to 65 Hz. Outside this frequency range, the error is max. 2%.

Table 24: AC Measuring Errors

AC Measuring Errors	**750-493, 750-493/025-000, 750-493/000-001 and 750-493/025-001**
Voltage	<= 0.3% of full-scale value
Current	<= 0.5% of full-scale value
Active power	<= 0.5%
Frequency	0.01 Hz

The measuring accuracy of the I/O module falls when an RMS voltage falls below 45 V. This state is called ZC limit and is displayed via the "D" LED (SAG LED). The following conditions can also degrade the measuring accuracy of the I/O module:

1. If only one or two phases of the three-phase supply network are connected, higher measuring errors can occur in the voltage measurement (+0.1%).

2. In AC networks only:
   If all phases fall below the ZC limit, accurate measurement of phase angle, frequency and current are no longer possible. The measuring accuracy of all current-depending variables (current, power, energy) falls off by 0.4%.

3. Near the ZC limit, the accuracy of the phase angle measurement decreases to a value of ± 1.5 °.

4. If a current measuring input operates near no-load, higher measuring errors can occur for this measuring path. Therefore, the measured current should be min. 75 mA for 750-493 resp. 100 mA for 750-493/000-001.

For **DC measurements**, the error is <= 1% of the full-scale value for current, voltage and power.

6 Mounting

6.1 Mounting Sequence

Fieldbus couplers/controllers and I/O modules of the WAGO-I/O-SYSTEM 750/753 are snapped directly on a carrier rail in accordance with the European standard EN 50022 (DIN 35).

The reliable positioning and connection is made using a tongue and groove system. Due to the automatic locking, the individual devices are securely seated on the rail after installation.

Starting with the fieldbus coupler/controller, the I/O modules are mounted adjacent to each other according to the project design. Errors in the design of the node in terms of the potential groups (connection via the power contacts) are recognized, as the I/O modules with power contacts (blade contacts) cannot be linked to I/O modules with fewer power contacts.

⚠ CAUTION

Risk of injury due to sharp-edged blade contacts!
The blade contacts are sharp-edged. Handle the I/O module carefully to prevent injury.

NOTICE

Insert I/O modules only from the proper direction!
All I/O modules feature grooves for power jumper contacts on the right side. For some I/O modules, the grooves are closed on the top. Therefore, I/O modules featuring a power jumper contact on the left side cannot be snapped from the top. This mechanical coding helps to avoid configuration errors, which may destroy the I/O modules. Therefore, insert I/O modules only from the right and from the top.

Note

Don't forget the bus end module!
Always plug a bus end module 750-600 onto the end of the fieldbus node! You must always use a bus end module at all fieldbus nodes with WAGO-I/O-SYSTEM 750 fieldbus couplers/controllers to guarantee proper data transfer.

6.2 Inserting and Removing Devices

NOTICE

Perform work on devices only if they are de-energized!
Working on energized devices can damage them. Therefore, turn off the power supply before working on the devices.

6.2.1 Inserting the I/O Module

1. Position the I/O module so that the tongue and groove joints to the fieldbus coupler/controller or to the previous or possibly subsequent I/O module are engaged.

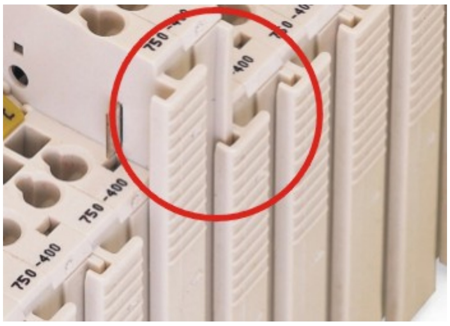


Figure 8: Insert I/O Module (Example)

2. Press the I/O module into the assembly until the I/O module snaps into the carrier rail.

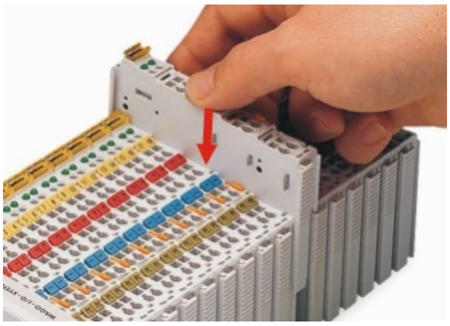


Figure 9: Snap the I/O Module into Place (Example)

With the I/O module snapped in place, the electrical connections for the data contacts and power jumper contacts (if any) to the fieldbus coupler/controller or to the previous or possibly subsequent I/O module are established.

6.2.2 Removing the I/O Module

1. Remove the I/O module from the assembly by pulling the release tab.

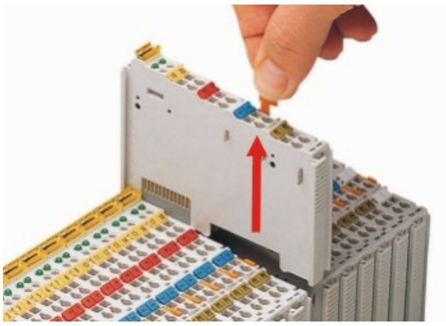


Figure 10: Removing the I/O Module (Example)

Electrical connections for data or power jumper contacts are disconnected when removing the I/O module.

7 Connect Devices

7.1 Connecting a Conductor to the CAGE CLAMP®

The WAGO CAGE CLAMP® connection is appropriate for solid, stranded and finely stranded conductors.

Note

Only connect one conductor to each CAGE CLAMP®!
Only one conductor may be connected to each CAGE CLAMP®.
Do not connect more than one conductor at one single connection!

If more than one conductor must be routed to one connection, these must be connected in an up-circuit wiring assembly, for example using WAGO feed-through terminals.

Exception:
If it is unavoidable to jointly connect 2 conductors, then you must use a ferrule to join the wires together. The following ferrules can be used:

Length:	8 mm
Nominal cross section $_{max.}$:	1 mm^2 for 2 conductors with 0.5 mm^2 each
WAGO product:	216-103 or products with comparable properties

1. For opening the CAGE CLAMP® insert the actuating tool into the opening above the connection.

2. Insert the conductor into the corresponding connection opening.

3. For closing the CAGE CLAMP® simply remove the tool. The conductor is now clamped firmly in place.

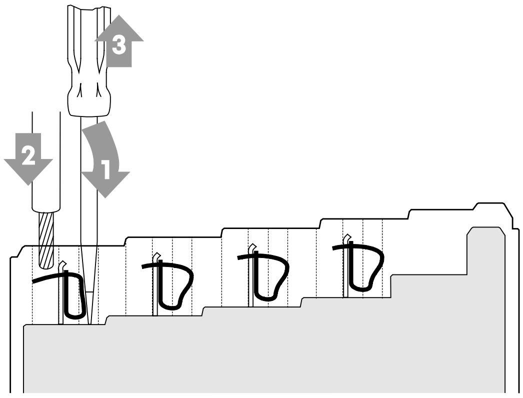


Figure 11: Connecting a Conductor to a CAGE CLAMP®

7.2 Voltage Measurement

In order to measure the 3 phase voltages of a supply network, connect its 4 wires with the CAGE CLAMPS® L1, L2, L3 and N.

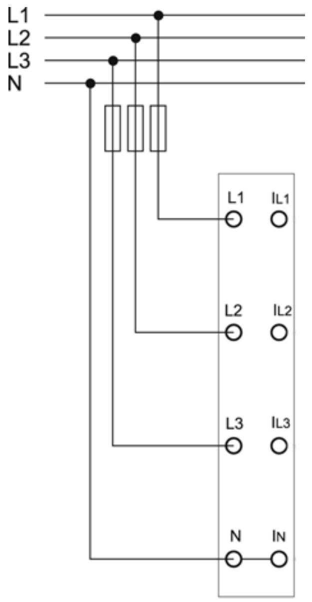


Figure 12: Voltage Measurement

7.3 Current Measurement

7.3.1 Current Measurement on a Motor

For measuring the currents of a 3 phase electrical motor connect it with the CAGE CLAMPS® IL1, IL2, IL3 and IN via current transformers.

DANGER

Connect CAGE CLAMP® N to earth, if not connected to the neutral wire!
If you do not connect the CAGE CLAMP® N with the neutral wire of the supply network (e.g. using the module for pure current measurement) you must connect N to earth PE to avoid hazardous voltages in the event of faults!

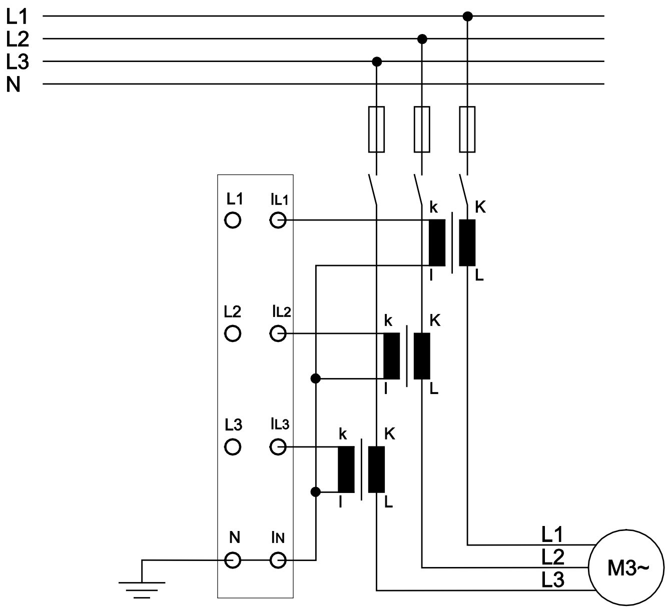


Figure 13: Current Measurement on a Motor

7.3.2 Current Transformers

For measuring currents greater than 1 A resp. 5 A you have to use external current transformers.
Normally, the selection of the current transformers is not a critical factor. The internal resistance in the current path of the 3-phase power measurement module is so low that it can be neglected when considering the overall resistance of the current loop.
The transformers must provide a rated secondary current of 1 A resp. 5 A. The rated primary current I_{pn} shall be equal or higher than the currents to be measured. The normal, permissible overload level of 1.2 x I_{pn} presents no problem for the 3-phase power measurement module, but can, however, lead to minor measurement inaccuracies.

NOTICE

Do not operate with open load!
Please note that current transformers from some manufacturers shall not be operated with an open output circuit! Connect the I/O module to the current transformers' secondary windings before commissioning the current transformers!

7.3.2.1 Accuracy

Please note that the overall accuracy of the measuring setup consisting of the 3-phase power measurement modules and the current transformers essentially depends on the transformers' accuracy category.

Note

Do not use transformers of class 0.5 for accounting purposes!
A measuring system with a class 0.5 current transformer cannot be approved or certified for accounting purposes as the 3-phase power measurement module is not an approved utility billing meter as defined in the standard for electricity meters (DIN 43 586).

7.3.2.2 Types of Current

The 3-phase power measurement module can measure any types of current up to a frequency of 2 kHz. As currents are frequently generated by power inverters and can contain frequencies lower than 50 Hz or even a DC portion, an electronic transformer should be used for these applications.

7.3.2.3 Overcurrent Limiting Factor FS

The overcurrent limiting factor (FS) for current transformers indicates at which multiple of its rated primary current saturation occurs which protects the connected measuring instruments. FS shall be max. 10 for the 1 A module resp. max. 5 for the 5 A module.

NOTICE

Note the max. continuous measuring current of 1 A resp. 5 A!
The max. continuous measuring current of the module is 1 A resp. 5 A. If the used transformers allow greater secondary currents than 1 A resp. 5 A install additional transformers with an appropriate transforming ratio!

7.3.2.4 Protection against Shock Hazard Voltages

No hazardous voltage is produced when the 3-phase power measurement module is used as specified, with appropriate current transformers. Secondary voltage is only a few Volts. Nevertheless, the following faults can result in high voltage levels:

- Open current path for one or more transformers
- Disconnected/cut N conductor at the voltage measuring end of the 3-phase power measurement module
- General insulation faults

DANGER

Install protection against electric shock!
All wiring for the measurement system shall be equipped with protection against shock hazard voltages along with the corresponding safety signs!

The 3-phase power measurement module permits a maximum voltage of 480 V for normal operating conditions. The voltages at the voltage inputs shall not exceed 480 V. For higher voltages use a transformer stage. This one however, shall not produce a phase angle shift (Yy0)!

The 3-phase power measurement module is equipped with a protective impedance of 1072 kΩ at the voltage measurement end. If the N conductor is not connected, and only one of the three voltage measuring terminals is under power, a voltage of 230 VAC to ground is yielded in a 3-phase system with a phase-to-phase voltage of 400 VAC. This voltage is also present at the current measuring end and can be measured using a multimeter with 10 MΩ input resistance. This does not represent an insulation fault.

7.3.3 Additional Measuring Instruments in the Current Path

Please note that adding measuring instruments (such as ammeters) in the current path can substantially increase the total apparent power.
In addition, the CAGE CLAMP® IN of the I/O module must form a star point (neutral) for the three secondary windings. See figure above. Therefore, additional measuring instruments must be potential-free and wired accordingly.

7.4 Power Measurement

7.4.1 Power Measurement on a Machine

For measuring power, all of the eight CAGE CLAMPS® have to be connected according to the figure below.

NOTICE

Do not confuse current and voltage clamps!
When making the connections do not confuse the current and voltage paths, as connecting the phase voltages directly to the low impedance current clamps IL1 … IL3 shall destroy the I/O module!

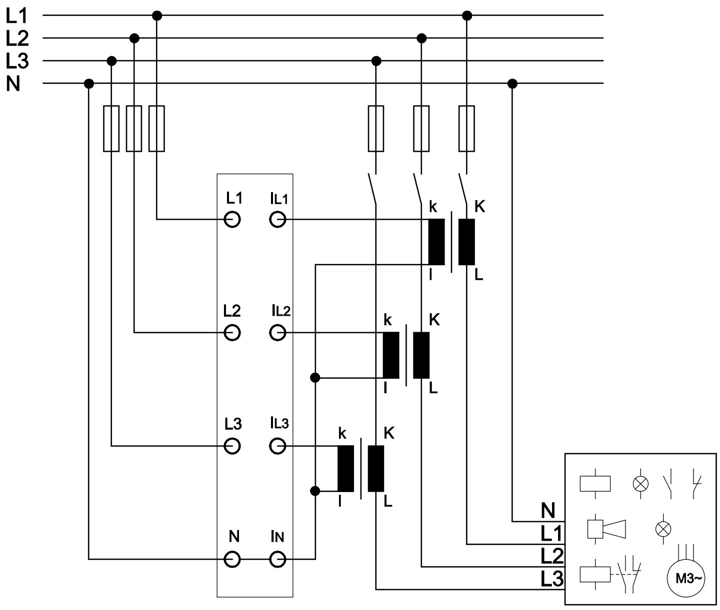


Figure 14: Power Measurement on a Machine

Note

Negative power values!
If you measure negative power values, check the connection of the associated current transformer circuit in the proper direction.

7.4.2

8 Commissioning

The I/O module latched in the bus node and wired for the measurement can be put into operation using the WAGO-I/O-*CHECK* software for Windows. For that, the fieldbus coupler/controller of the node is connected, for example, to the USB port of a PC using the WAGO USB communication cable.
WAGO-I/O-*CHECK* provides the following functions:

- Graphic display of the bus node
- Display of the process data (measured values)
- Application settings
- Settings for the measurements for each of the three phases
- I/O module settings
- Settings for saving the energy values

Information

WAGO-I/O-*CHECK*
You can obtain the WAGO-I/O-*CHECK* software on a CD under Item No. 759-302. This CD contains all the application program files and a description.
The description is also available in the Internet at http://www.wago.com under Documentation > WAGO Software > WAGO-I/O-*CHECK*.

To display the bus node on the PC, use the USB communication cable to connect coupler/controller and PC and launch WAGO-I/O-*CHECK*.

8.1 Configuration with WAGO-I/O-*CHECK*

Right-click on the image of the I/O module and select the **[Settings]** menu item.

See the figure below:

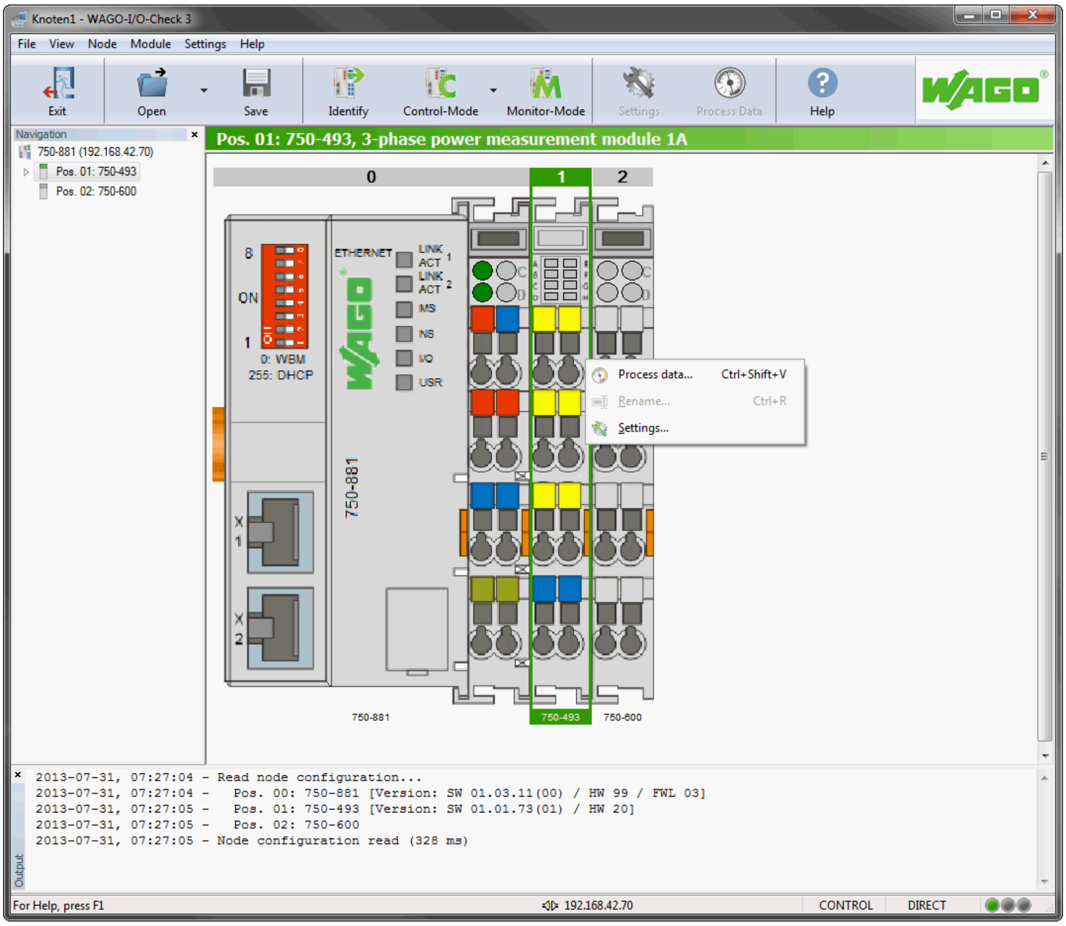


Figure 15: WAGO-I/O-*CHECK* User Interface, Bus Node with I/O Module

The "3-phase power measurement" dialog opens. See figure below.

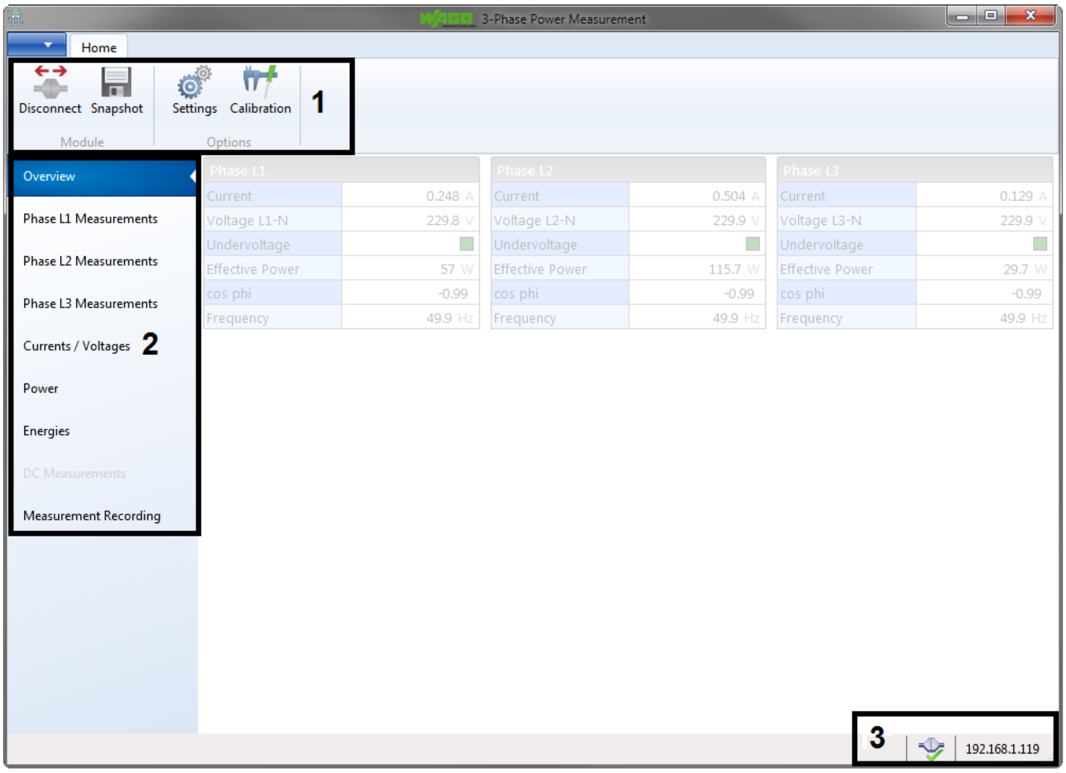


Figure 16: "3-Phase Power Measurement" Dialog

The following buttons appear in the **Home (1)** ribbon:

[**Disconnect**]	Separates the fieldbus coupler/controller from the PC
[**Snapshot**]	Opens a "Save as" dialog to save all current measured values and I/O module settings as a CSV file. In this dialog, enter a file name and select a location to save the file, e.g. see section "Appendix".
[**Settings**]	Opens the settings dialog.
[**Calibration**]	Opens the calibration dialog. More information is available from the WAGO Support.

The buttons for the individual **measured value views** appear in the **menu (2)**.

The **status bar (3)** displays the connection icon and IP address of the fieldbus coupler/controller or the name of the COM port.

Click **[Settings]** to open the "Settings" dialog in which you can configure the application and I/O module.

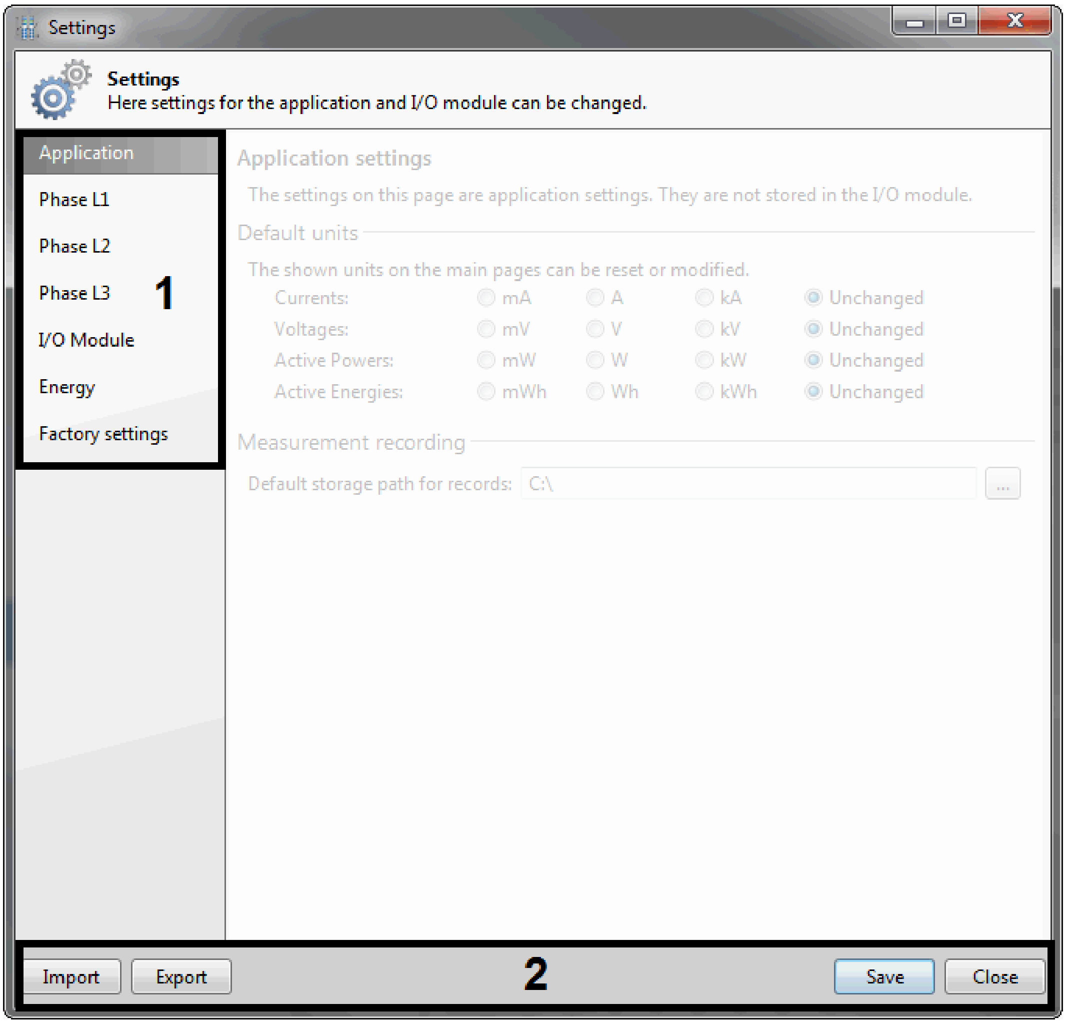


Figure 17: "Settings" Dialog

The **main menu (1)** with the Application, Phase L1, Phase L2, Phase L3, I/O Module, Energy and Factory Settings tabs are on the left side. These are explained in more detail in the following sections.

At the window's bottom you can find the **command bar (2)** with 4 buttons.
Use **[Import]** to load the settings from your hard drive that you may have already saved when setting up another I/O module. You can change these settings if necessary and then **[Save]** them to the I/O module.
Use **[Export]** to save the current settings to your computer to simplify future configurations.

Note

Pay attention to energy values!
The energy values are not taken into account when importing and exporting!

[Save] writes any changed settings to registers, i.e. the configuration of the I/O module and the application settings are changed. The "Settings" dialog closes.
To not save and discard the changed settings, click **[Close]**. The "Settings" dialog closes.

8.1.1 "Application" Tab

Make application settings in the "Application" tab. These settings are not stored in the I/O module, but on the connected PC.

You specify again the decimal multiples for displaying the measuring units for the various measured variables or keep them:
10^{-3}=milli or 10^{0}=1 or 10^{3}=kilo.

In addition, you specify the storage path for the measured value records. See "Measurement Recording" in the following section "Displaying the Measured Values via WAGO-I/O-*CHECK*".

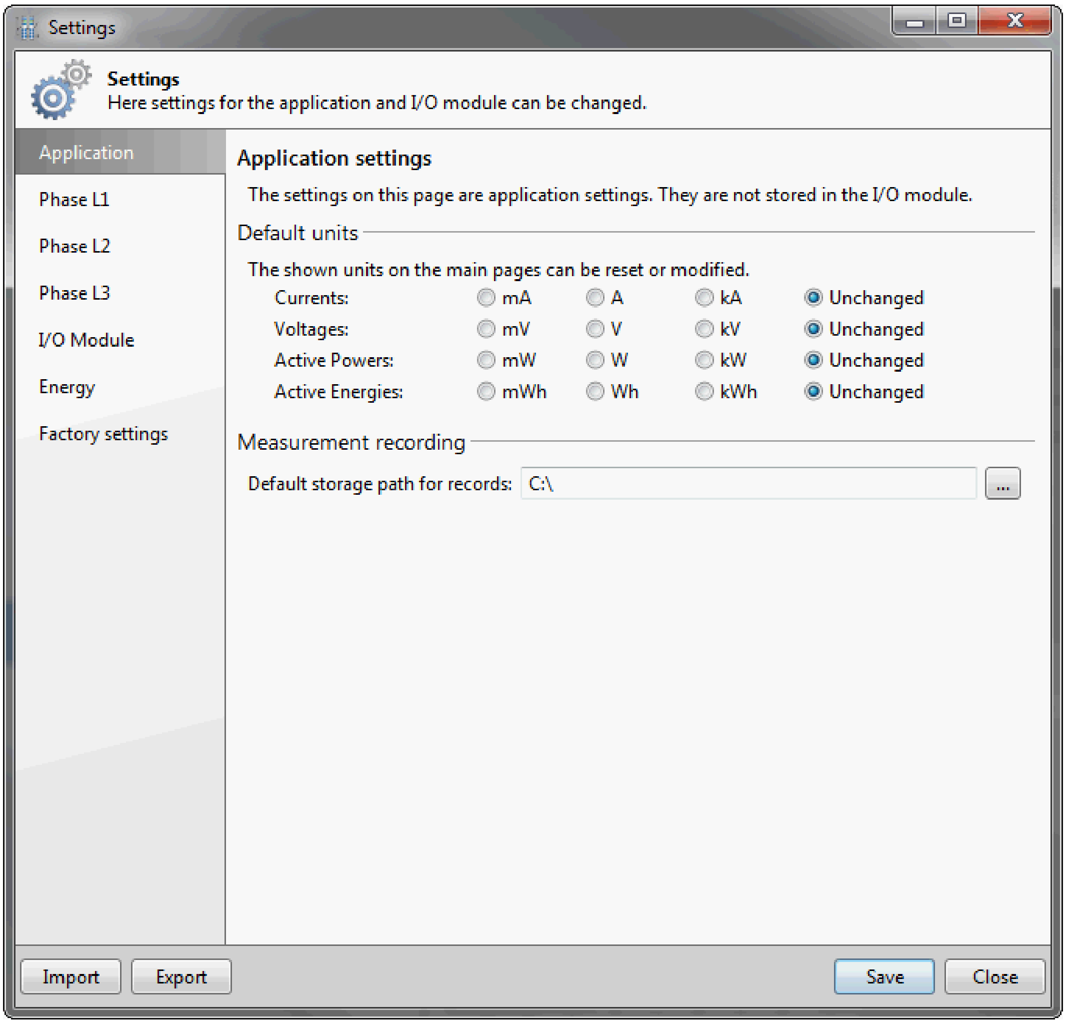


Figure 18: "Application" Tab

8.1.2 "Phase L1", "Phase L2", "Phase L3" Tabs

Use the "Phase L1", "Phase L2", "Phase L3" tabs to configure user scaling, energy, min.-/max. values and general parameters. These settings are saved to the I/O module.

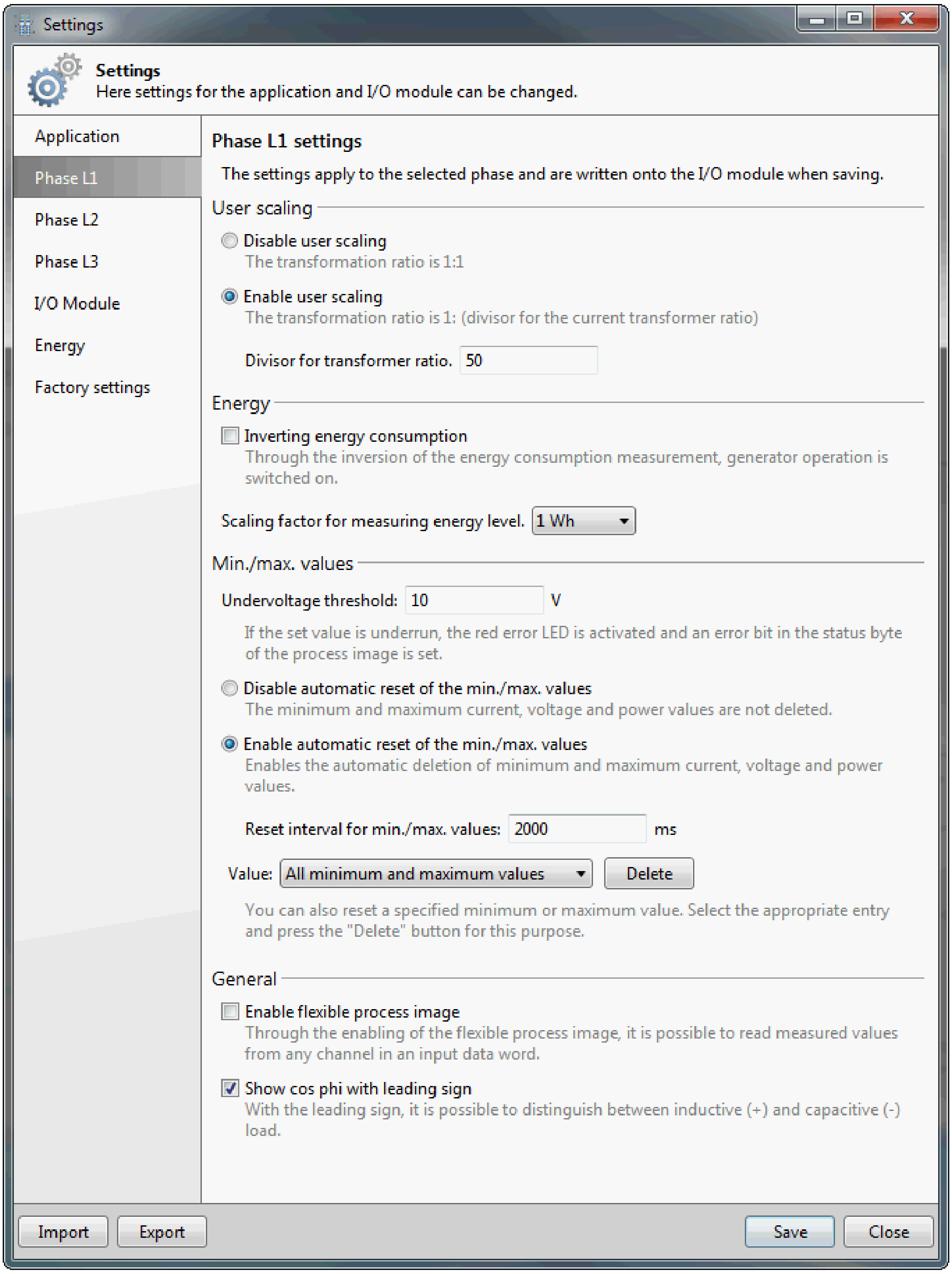


Figure 19: "Phase L1" Tab

In the event that you use current transformers to measure high currents, specify in user scaling whether you want to take into account the current transformer ratio when calculating the measured values in the respective phase or not. If yes, specify the divisor of the current transformer ratio D-CTR, e.g. "40". The maximum possible value is "50".
If no, you must take the divisor into account in the higher-level PLC as a factor. Register 32 and 37 are written. For details, see section "Functional Description".

For "Energy", specify whether you want to measure a motor, i.e. a load or a generator and select the scaling factor for energy measurement, e.g. 0.01 kWh. The Register 35 is written.

For "Min.-/Max. values", specify the undervoltage threshold value and define whether the min.-/max. values are automatically reset after a specific time or not. In addition, you can reset specific min.-/max. values by selecting them and clicking **[Delete]**.

You can also enable two checkboxes: "Enable flexible process image" and "Show cos phi with leading sign". For flexible process image, see also section "Process Image" > "Flexible Process Image".

8.1.3 "I/O Module" Tab

On the "I/O Module" tab you can do two general settings for the entire I/O module. These are "Enable watchdog" and "Enable DC measurement". The watchdog deactivates the green status LED "A" if no process data is received within 100 ms.

You can also specify the measuring cycle time. The minimum value is 39 ms, default is also 39 ms. The maximum value is 24375 ms.

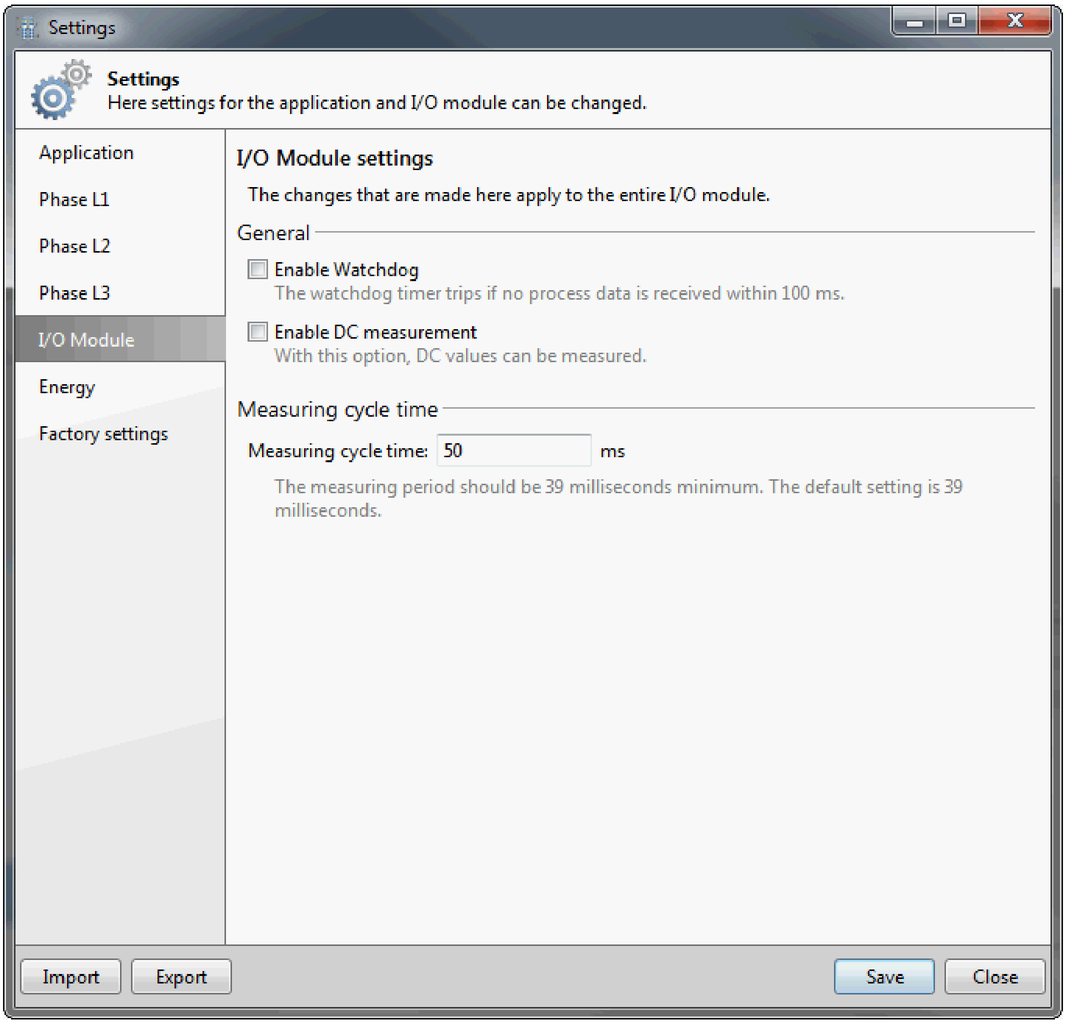


Figure 20: "I/O Module" Tab

8.1.4 "Energy" Tab

After entering a password, you can set or reset the energy values per phase on the "Energy" tab. The initial password is: wago. Please change this password on first use by clicking **[Change password]**.
The energy values are saved automatically every 15 minutes. Use the **[Save]** and **[Delete]** commands to save the actual value or set it to 0. These actions are carried out immediately and cannot be undone. Therefore, the **[Save]** button is disabled at the bottom of the window.

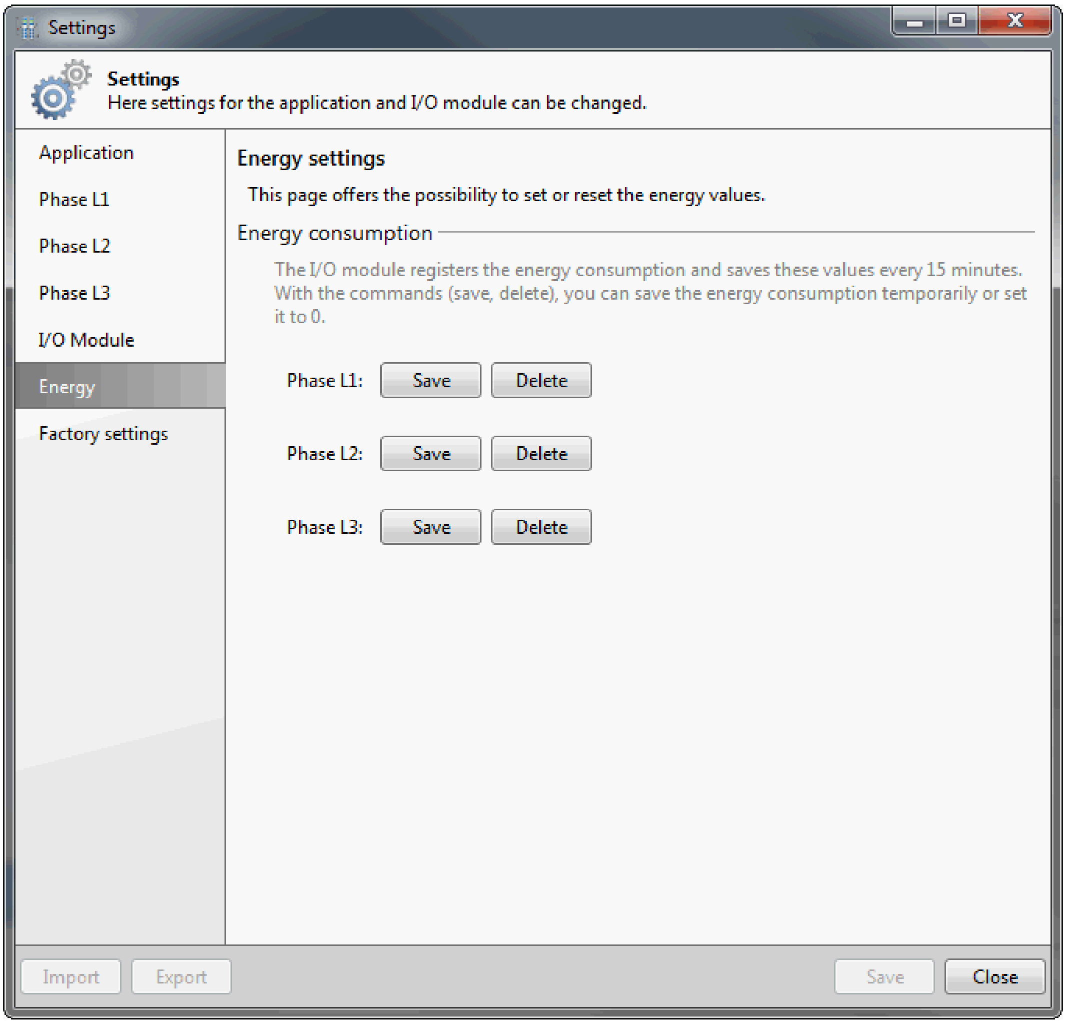


Figure 21: "Energy" Tab

8.1.5 "Factory Settings" Tab

After entering a password (see "Energy" tab above), you can reset all parameters of the I/O module to their factory settings on the "Factory Settings" tab.

Use I/O Module Settings [**Restore**] to reset the I/O module settings only. Calibration data remains unchanged.
Use Calibration Data **[Restore]** to reset the calibration data only. The I/O module settings remain unchanged.
Use Total **[Restore]** to reset all I/O module settings and calibration data.
These actions are carried out immediately and cannot be undone. Therefore, the **[Save]** button is disabled at the bottom of the window.

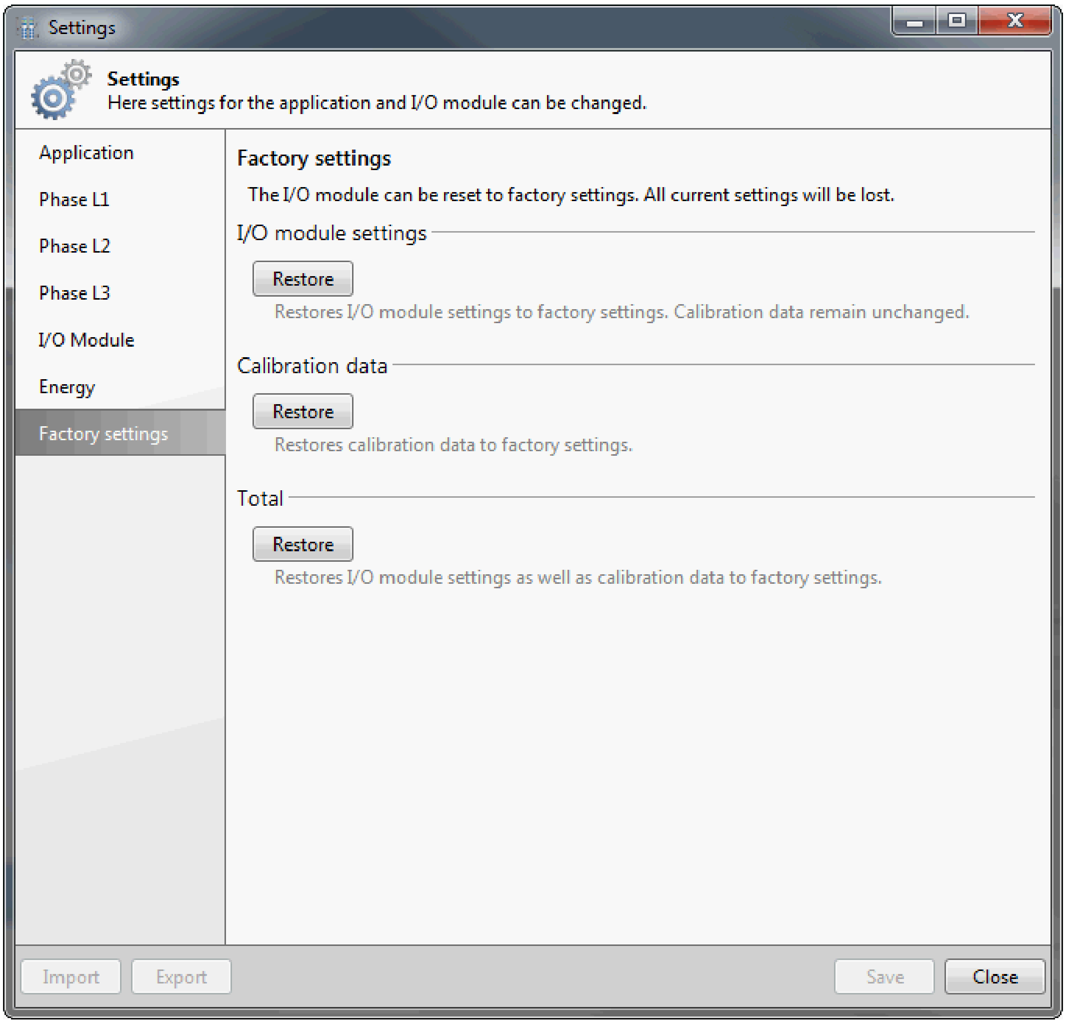


Figure 22: "Factory Settings" Tab

8.1.6 Register Assignment

The following tables display the assignments and factory settings for the individual registers written by setting the parameters.
The factory settings are the same for all three channels.

Table 25: Register 0

<table>
<tr><th colspan="4">Register 0 - Overflow register for energy consumption</th></tr>
<tr><th>Function</th><th>Data type</th><th>Access</th><th>Factory setting</th></tr>
<tr><td>Overflow register for energy consumption</td><td>UINT</td><td>R/W</td><td>----</td></tr>
<tr><td colspan="4">This overflow register is incremented when the register for energy consumption (can be read out via process data index 4) starts to overrun. The overflow register can only be read out via register communication.
When the energy consumption data is deleted, this register is likewise deleted.</td></tr>
</table>

Table 26: Register 7

<table>
<tr><th colspan="5">Register 7 - Command register</th></tr>
<tr><th colspan="2">Function</th><th>Data type</th><th>Access</th><th>Factory setting</th></tr>
<tr><td colspan="2">Command register</td><td>UINT</td><td>R/W</td><td>0x0000</td></tr>
<tr><td>0x0000</td><td colspan="4">No function.
If needed, enter the value 0x0000 into the command register to delete it.</td></tr>
<tr><td>0x1004</td><td colspan="4">Deleting energy consumption data (user password must be set).
Write the value 0x1004 to the command register to delete the energy consumption value stored in the process data (process data index 4) and the overflow register for energy consumption (R0).</td></tr>
<tr><td>0x1005</td><td colspan="4">Deleting the maximum current value.
Write the value 0x1005 to the command register to delete the maximum current value stored in the process data (process data index 5).</td></tr>
<tr><td>0x1006</td><td colspan="4">Deleting the maximum voltage value.
Write the value 0x1006 to the command register to delete the maximum voltage value stored in the process data (process data index 6).</td></tr>
<tr><td>0x1009</td><td colspan="4">Deleting the minimum current value.
Write the value 0x1009 to the command register to delete the minimum current value stored in the process data (process data index 9).</td></tr>
<tr><td>0x100A</td><td colspan="4">Deleting the minimum voltage value.
Write the value 0x100A to the command register to delete the minimum voltage value stored in the process data (process data index 10).</td></tr>
<tr><td>0x1014</td><td colspan="4">Intermediate saving of energy consumption value (user password must be set).
The I/O module registers the energy consumption in the RAM and only saves these values to the EEPROM in 15 minute cycles.
If you wish to deactivate the I/O module without losing the energy consumption value measured since the last storage cycle, you can store the actual value manually to the EEPROM using this command.</td></tr>
<tr><td colspan="5">NOTICE
Lifetime of EEPROM!
If the energy values are stored in 60 s cycles, the lifetime of the EEPROM amounts to 19 years. Storing every 30 s the lifetime decreases to 9.5 years!</td></tr>
<tr><td>0x1020</td><td colspan="4">Deleting all minimum and maximum values.
Write the value 0x1020 to the command register to delete all minimum and maximum values.</td></tr>
<tr><td>0x7000</td><td colspan="4">Restoring factory settings (user password must be set).
Write the value 0x7000 to the command register to restore the factory settings of registers 32 and 35 … 39. Resetting one channel automatically resets the two other channels.</td></tr>
</table>

Table 27: Register 32

Register 32 - Mode setting				
Function		**Data type**	**Access**	**Factory setting**
Mode setting		Flags	R/W	0x0020
Bit 0: enUserScaling				
0: *	User scaling deactivated; the transformation ratio is 1:1.			
1:	User scaling activated; the transformation ratio is 1: (divisor for the current transformer ratio).			
Bit 1: reserved				
Bit 2: disWdTimer				
0: *	Watchdog timer activated: The watchdog trips and deactivates the green status LED “A” if no process data is received within 100 ms.			
1:	Watchdog timer not activated.			
Bit 3: enFlexProcImage				
0: *	Simple process image (compatibility mode)			
1:	Flexible process image			
Bit 4: skipDCFilter				
0: *	DC filter activated			
1:	DC filter is bypassed			
Bit 5: reserved				
Bit 6: invEnergySign				
0: *	Energy consumption measurement not inverted.			
1:	Energy consumption measurement inverted (generating operation)			
Bit 7: enClrMinMaxValues				
0: *	Automatic deleting of minimum and maximum current, voltage and power values deactivated.			
1:	Automatic deleting of minimum and maximum current, voltage and power values activated.			
Bit 8 … 15: reserved				

* Factory setting

Table 28: Register 35

Register 35 - Scaling factor for measuring energy				
Function		**Data type**	**Access**	**Factory setting**
Scaling factor for measuring energy		UINT	R/W	0x0004
	750-493	750-493/000-001		
0:	1 mWh	5 mWh		
1:	0.01 Wh	0.05 Wh		
2:	0.1 Wh	0.5 Wh		
3:	1 Wh	5 Wh		
4: *	0.01 kWh	0.05 kWh		
5:	0.1 kWh	0.5 kWh		
6:	1 kWh	5 kWh		
≥7:	reserved	reserved		

* Factory setting

Table 29: Register 36

Register 36 - Undervoltage threshold			
Function	**Data type**	**Access**	**Factory setting**
Undervoltage threshold; resolution 0.1 V	UINT	R/W	0x0064 (10 V)

Table 30: Register 37

Register 37 - Divisor for current transformer ratio D-CTR			
Function	**Data type**	**Access**	**Factory setting**
Divisor for current transformer ratio; must be activated via register 32, bit 0	UINT	R/W	0x0001 (D-CTR = 1)

Table 31: Register 38

Register 38 - Time constant for automatic deleting of minimum and maximum values			
Function	**Data type**	**Access**	**Factory setting**
Time constant for automatic deleting of minimum and maximum values; resolution 10 ms; must be activated via register 32, bit 7	UINT	R/W	0x00C8 (2000 ms)

Table 32: Register 39

Register 39 - Measuring cycle period			
Function	**Data type**	**Access**	**Factory setting**
Measuring cycle period; resolution 1 ms	UINT	R/W	0x0027 (39 ms)

8.2 Displaying the Measured Values via WAGO-I/O-*CHECK*

The measured values are displayed in the "3-phase power measurement" dialog in several views.

The **Overview** view displays the measured values of all three phases continuously. These are:

- Current, voltage Lx-N, active power, cos phi and frequency.

An undervoltage is identified as a red square.

Information

Change of the Measuring Units!
Specify the prefixes of the measuring units by selecting Home > Settings > Application. See section "Configuration with WAGO-I/O-*CHECK*" > "Application" Tab.
The units can only be changed in the lists with the same physical variables. For lists with different variables, base units are always used!

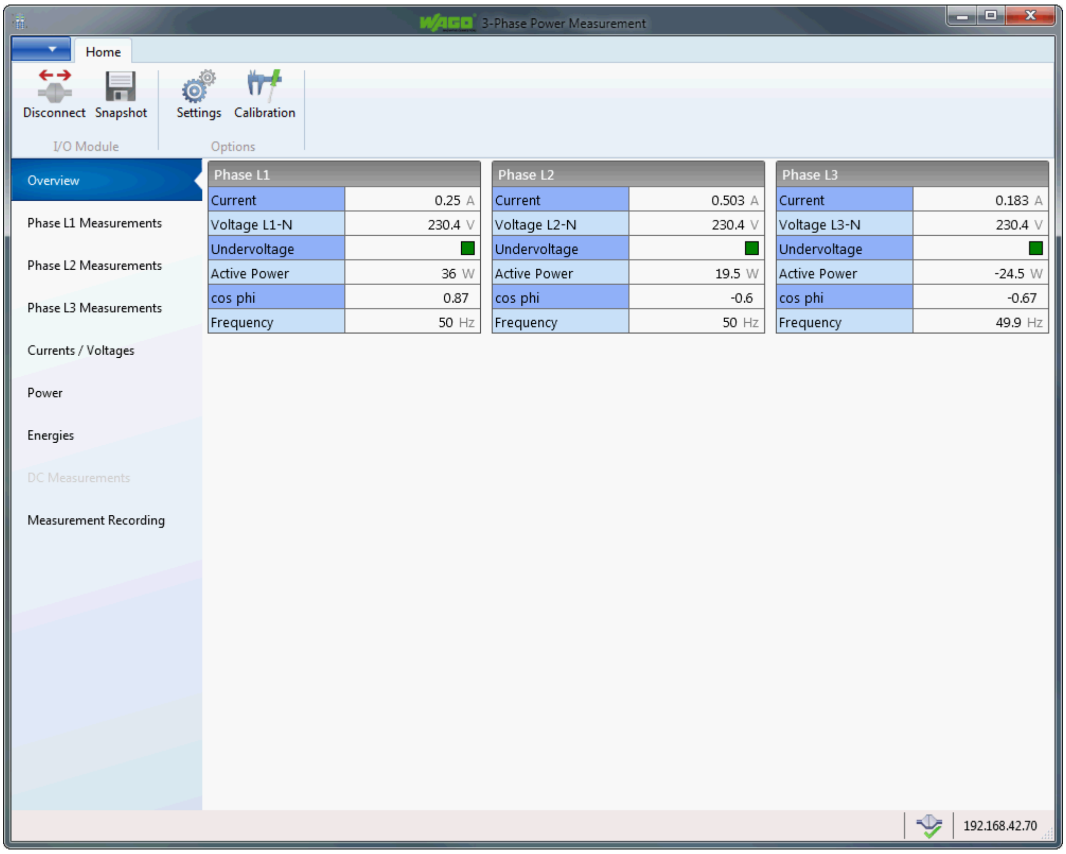


Figure 23: Measured Values, Overview

Selecting **Phase L1 (resp. L2 or L3) Measurements**, the measured values of the respective phase are displayed in detailed including min. and max. values and active energy.

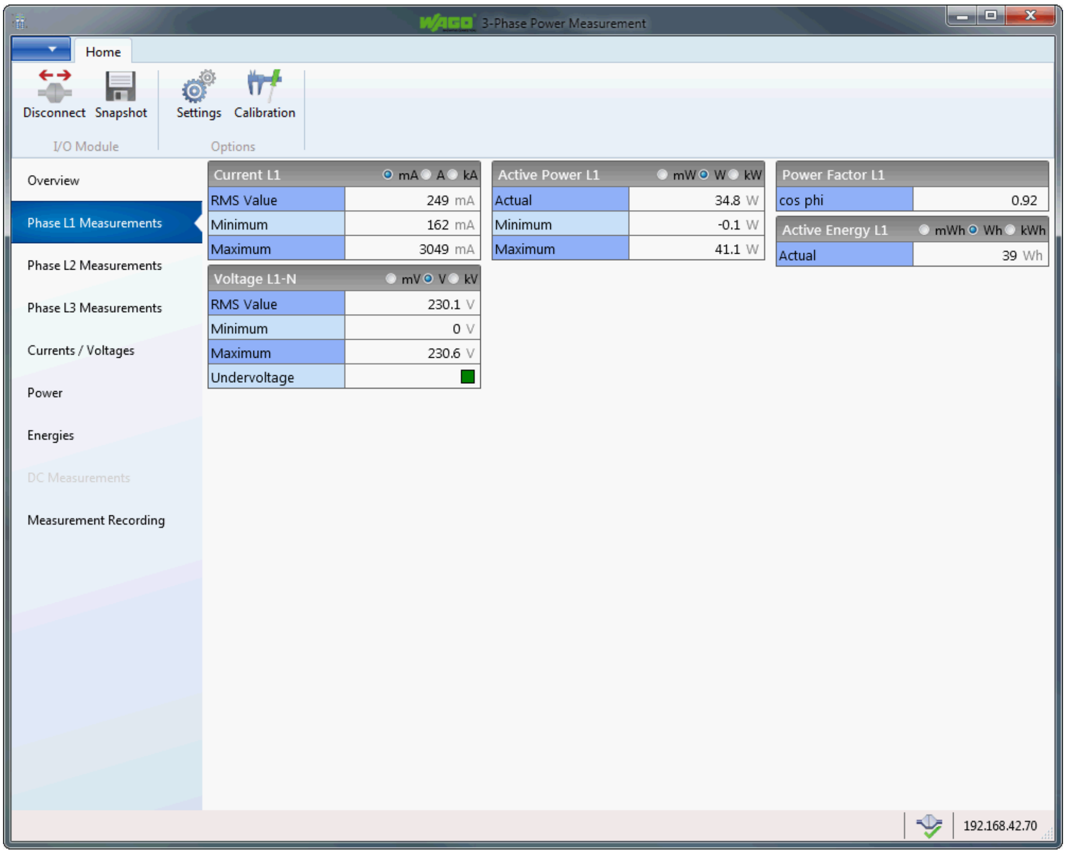


Figure 24: Measured Values, Phases

Currents/Voltages displays all three currents with min. and max. values, all three voltages with min. and max. values, undervoltages and all three frequencies.

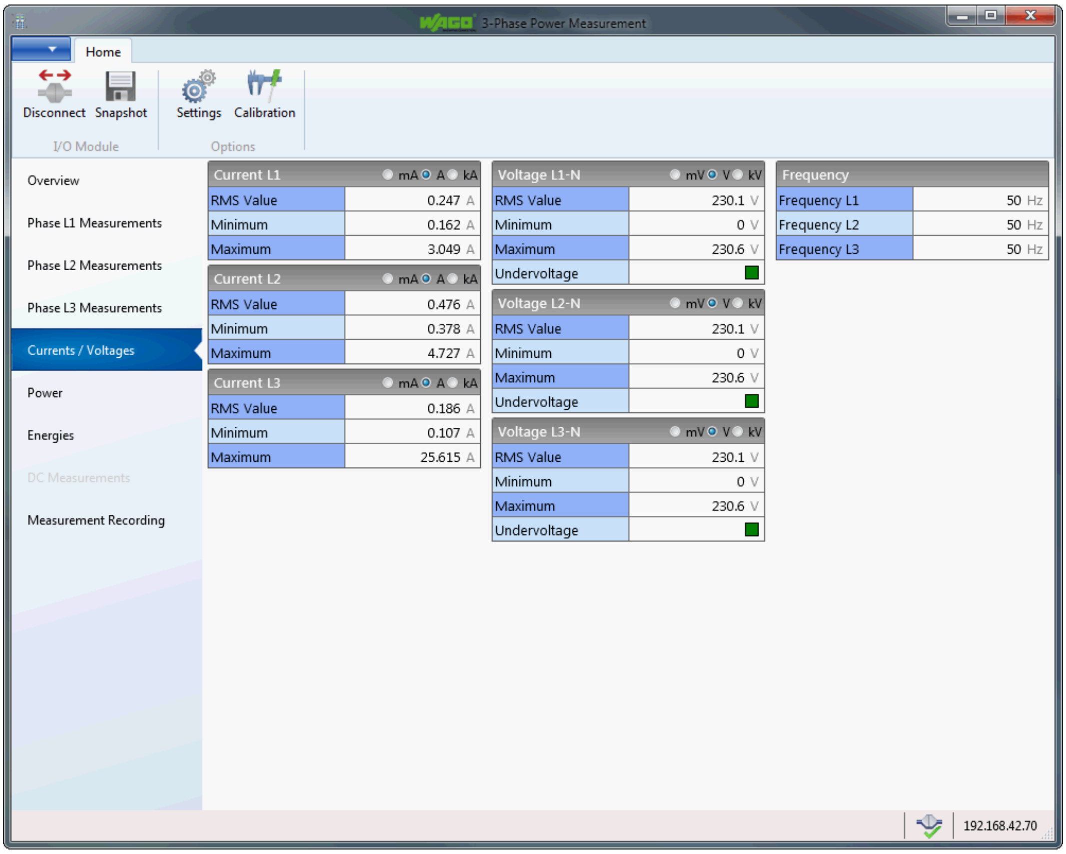


Figure 25: Measured Values, Currents and Voltages

If you select **Power**, the active power of the three phases is displayed with min. and max. values and the power factor cos phi.

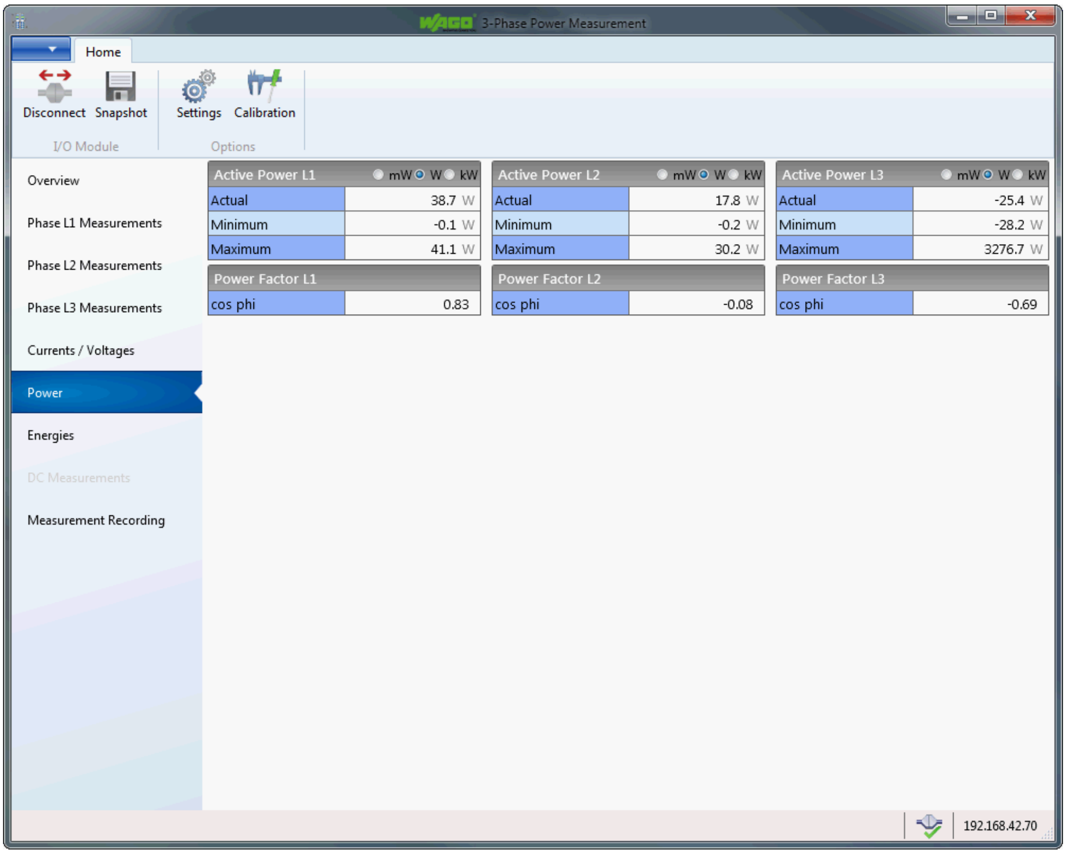


Figure 26: Measured Values, Power

If you select **Energies**, the three total active energies are displayed that have been consumed/generated since the beginning of the measurement.

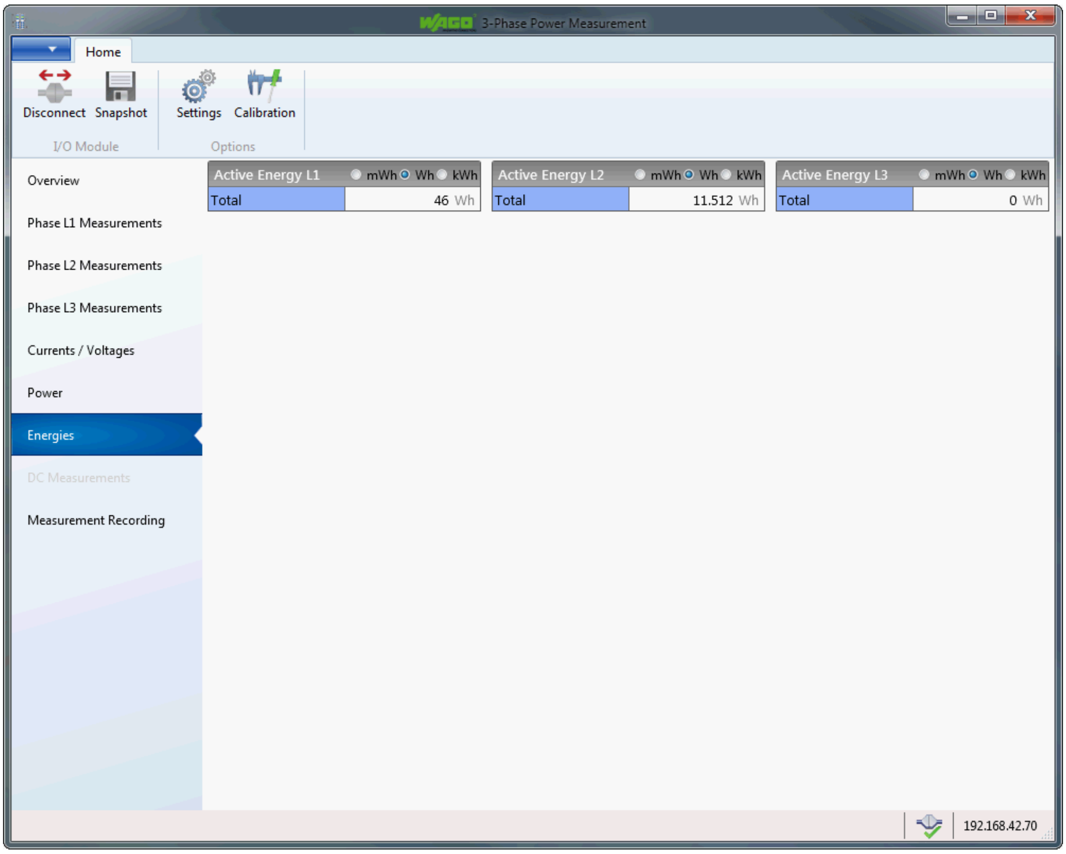


Figure 27: Measured Values, Energies

Selecting **DC Measurements**, you can see the measured DC components of the three measuring signals, i.e. current, voltage and power of each measuring signal is displayed. Select DC mode on the "I/O Module" tab. The AC variables are then not measured and displayed.

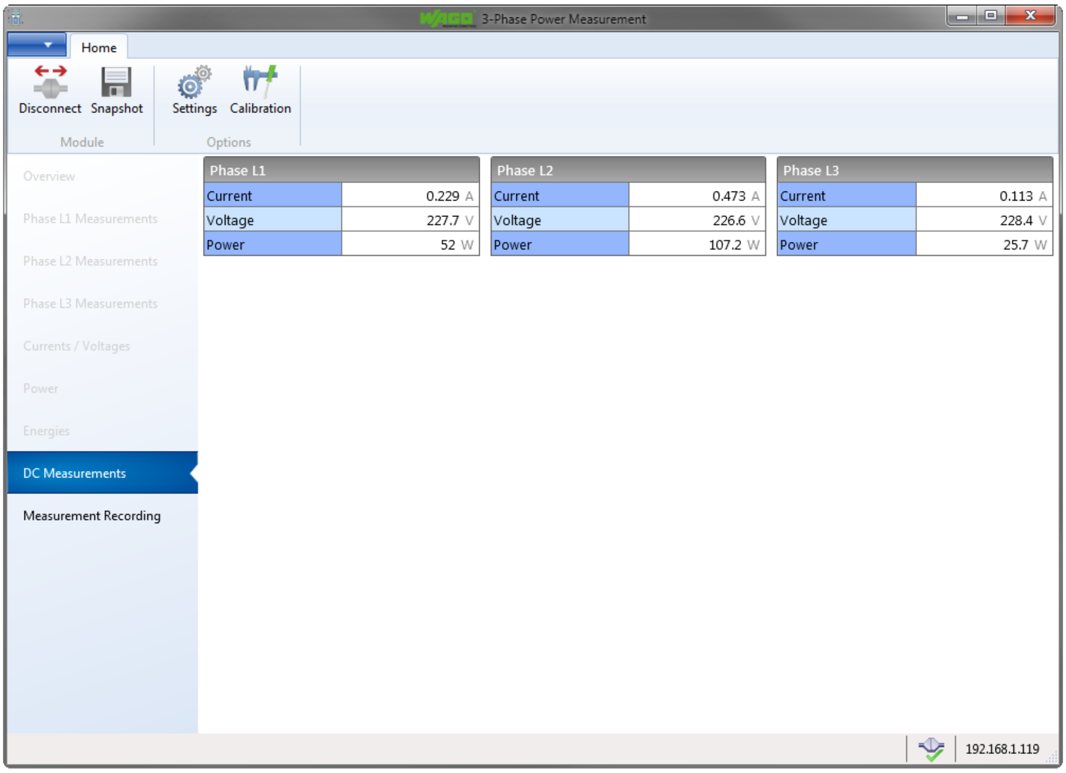


Figure 28: Measured Values, DC

On the **Measurement Recording** view, 3 measured variables are represented in chronological sequence. You can select the measured variables you want to see in the 3 drop-down lists.

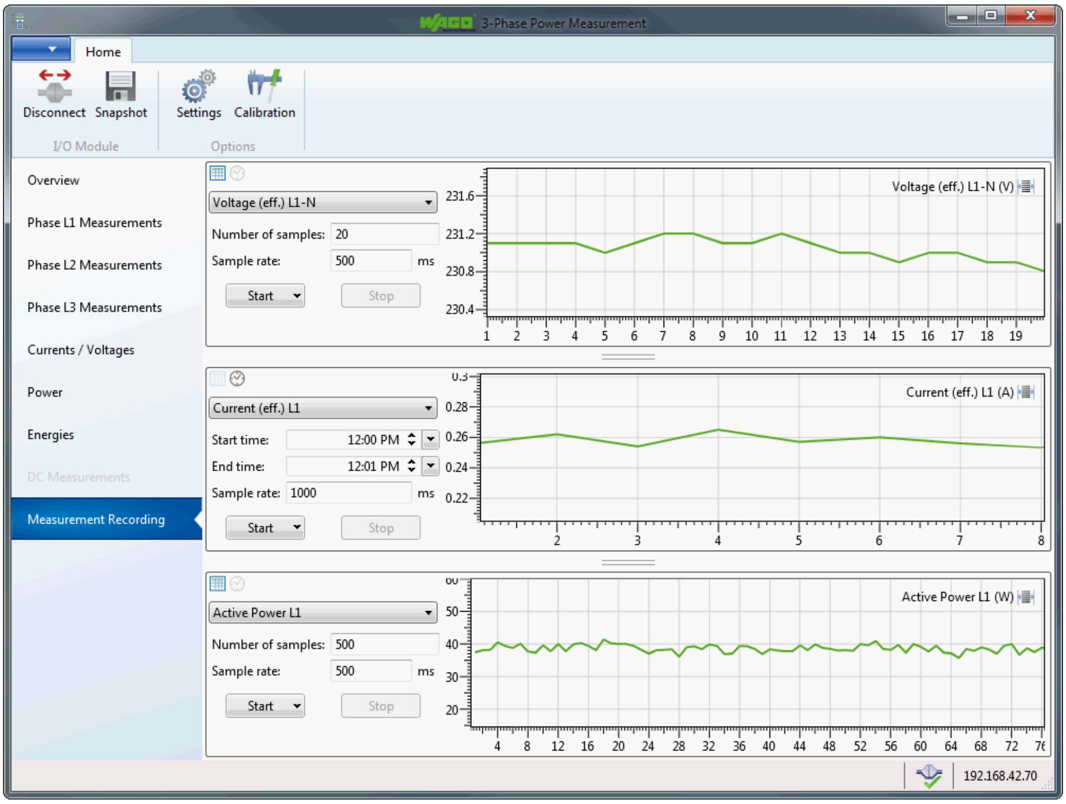


Figure 29: Measured Values, Recording

In general, you can select in the 3 waveforms whether:

- The samples are displayed over a certain period of time (with).
  or
- A certain number of samples is displayed (with).

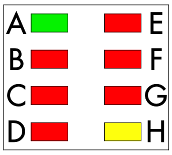
You can then enter the duration by start and end time or the number of samples. In both cases, the measurement interval, i.e. sample rate, can also be selected from 250 to 300,000 ms.

Clicking the arrow, the [**Start**] button generates a drop-down list in which you can select "No Export". By doing this, no export CSV file is generated.
If you click [**Start**] as usual, a "Save" window opens in which you can specify the storage location for the CSV file. After you have specified the storage location the measurement starts. Use [**Stop**] to stop the measurement prematurely. For examples of CSV files, see section "Appendix".

Use the mouse wheel to zoom in and out within the three graphic waveforms.
Hold down the left mouse button to move the displayed range.
Click again to follow the current waveform.

9 Diagnostics

8 LEDs A … H indicate the operation status and possible errors.



The meaning of the indications is as follows:

Table 33: LED Diagnosis

LED	Status	Message
A	Off	No operational readiness or the internal data bus communication is interrupted.
	Green	Operational readiness and correct internal data bus communication
B	Off	No error
	Red	Undervoltage L1 – N *
C	Off	No error
	Red	Override of a current measuring path
D	Off	No error
	Red	High measuring error, caused by undervoltage of a voltage measuring path
E	Off	No error
	Red	Undervoltage L2 – N *
F	Off	No error
	Red	Undervoltage L3 – N *
G	Off	No error
	Red	Override of a voltage measuring path
H	Off	No error
	Yellow	Error of the phase sequence L1-L2-L3

*The undervoltage threshold is set on the tabs „Phase L1“, „Phase L2“ and „Phase L3“.

10 Appendix

10.1 CSV Data File "Snapshot"

The following table is an example CSV data file generated in WAGO-I/O-*CHECK* with the function [**Snapshot**].
All actual measured values and set parameters are listed.

7/30/2013 11:50:46 AM	WAGO Kontakttechnik GmbH & Co. KG	I/O-Check- 3 Phase Power Measurement (1.3.3.366)	0750-0493 /0000-0000
Measurements			
Current (eff.) L1	0.261 A		
Current (eff.) L3	0.188 A		
Current (eff.) L2	0.48 A		
Voltage (eff.) L1-N	230.4 V		
Voltage (eff.) L2-N	230.4 V		
Voltage (eff.) L3-N	230.4 V		
Active Power L1	38.1 W		
Active Power L2	18 W		
Active Power L3	-25.8 W		
cos phi L1	0.75		
cos phi L2	0.11		
cos phi L3	-0.84		
Frequency L1	50 Hz		
Frequency L2	50 Hz		
Frequency L3	49.9 Hz		
Minimum Current (eff.) L1	0.162 A		
Minimum Current (eff.) L2	0.107 A		
Minimum Current (eff.) L3	0.378 A		
Maximum Current (eff.) L1	3.049 A		
Maximum Current (eff.) L2	4.727 A		
Maximum Current (eff.) L3	25.615 A		
Minimum Voltage (eff.) L1-N	0 V		
Minimum Voltage (eff.) L2-N	0 V		
Minimum Voltage (eff.) L3-N	0 V		
Maximum Voltage (eff.) L1-N	230.6 V		

Maximum Voltage (eff.) L2-N	230.6 V		
Maximum Voltage (eff.) L3-N	230.6 V		
Minimum Active Power L1	-0.1 W		
Minimum Active Power L2	-0.2 W		
Minimum Active Power L3	-28.2 W		
Maximum Active Power L1	42.8 W		
Maximum Active Power L2	30.2 W		
Maximum Active Power L3	3276.7 W		
Active Energy L1	60 Wh		
Active Energy L2	17.812 Wh		
Active Energy L3	0 Wh		
Parameter Phase L1			
Transformer ratio	300		
Heed transformer ratio	True		
Flexible process image active	False		
Leading sign cos phi positive and negative	True		
Energy measurement generator operation	False		
Automatic reset of the min./max. values	False		
Scaling factor energy values	1 Wh		
Undervoltage threshold	0 V		
Interval - reset: min./max. values	2000 ms		
Parameter Phase L2			
Transformer ratio	700		
Heed transformer ratio	True		
Flexible process image active	False		
Leading sign cos phi positive and negative	True		
Energy measurement generator operation	False		
Automatic reset of the min./max. values	False		
Scaling factor energy values	1 mWh		
Undervoltage threshold	0 V		
Interval - reset: min./max. values	2000 ms		
Parameter Phase L3			

Transformer ratio	200		
Heed transformer ratio	True		
Flexible process image active	False		
Leading sign cos phi positive and negative	True		
Energy measurement generator operation	False		
Automatic reset of the min./max. values	False		
Scaling factor energy values	1 mWh		
Undervoltage threshold	0 V		
Interval - reset: min./max. values	2000 ms		
I/O Module Parameters			
DC current measurement active	False		
Watchdog process data communication active	False		
Measuring cycle time	50 ms		

10.2 CSV Data File "Measurement Recording"

The following table shows an example CSV data file generated in the view "Measurement Recording" with [**Start**]. In this example the variable "Voltage (eff.) L1-N" was selected shown as measuring series with 10 values.

04.07.2013 07:47:24	WAGO Kontakttechnik GmbH & Co. KG	I/O-Check-3 Phase Power Measure-ment (1.3.3.366)	0750-0493 /0000-0000	Voltage (eff.) L1-N	V
04.07.2013 07:47:24	230				
04.07.2013 07:47:25	230				
04.07.2013 07:47:25	229.9				
04.07.2013 07:47:26	230				
04.07.2013 07:47:26	229.9				
04.07.2013 07:47:27	230				
04.07.2013 07:47:27	229.9				
04.07.2013 07:47:28	230				
04.07.2013 07:47:28	230				
04.07.2013 07:47:29	230				

11 Use in Hazardous Environments

The **WAGO-I/O-SYSTEM 750** (electrical equipment) is designed for use in Zone 2 hazardous areas.

The following sections include both the general identification of components (devices) and the installation regulations to be observed. The individual subsections of the “Installation Regulations” section must be taken into account if the I/O module has the required approval or is subject to the range of application of the ATEX directive.

11.1 Marking Configuration Examples

11.1.1 Marking for Europe According to ATEX and IEC-Ex

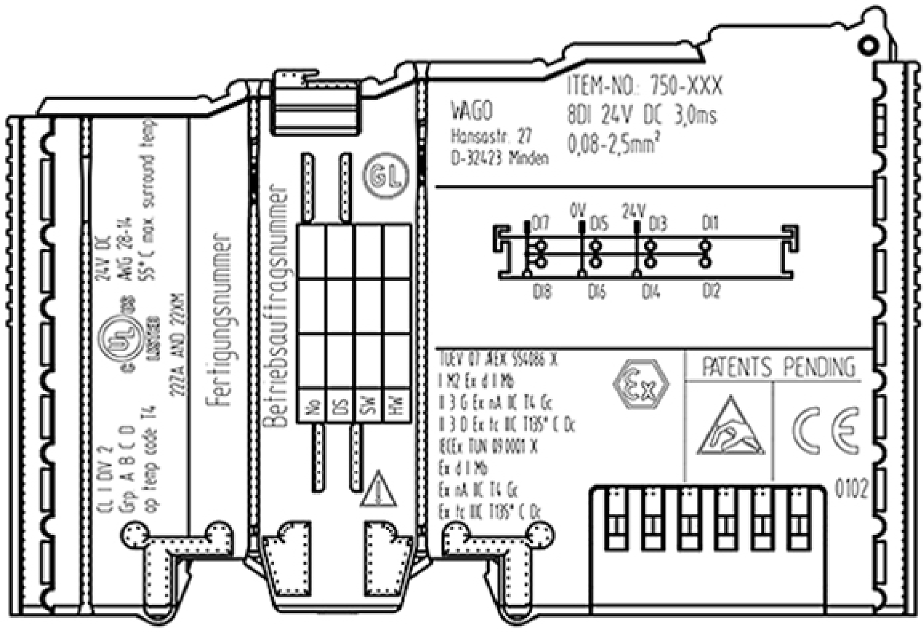


Figure 30: Side Marking Example for Approved I/O Modules According to ATEX and IECEx

Figure 31: Text Detail – Marking Example for Approved I/O Modules According to ATEX and IECEx.

Table 34: Description of Marking Example for Approved I/O Modules According to ATEX and IECEx

Printing on Text	Description
TÜV 07 ATEX 554086 X IECEx TUN 09.0001 X	Approving authority and certificate numbers
Dust	
II	Equipment group: All except mining
3D	Category 3 (Zone 22)
Ex	Explosion protection mark
tc Dc	Type of protection and equipment protection level (EPL):protection by enclosure
IIIC	Explosion group of dust
T 135°C	Max. surface temperature of the enclosure (without a dust layer)
Mining	
I	Equipment group: Mining
M2	Category: High level of protection
Ex	Explosion protection mark
d Mb	Type of protection and equipment protection level (EPL): Flameproof enclosure
I	Explosion group for electrical equipment for mines susceptible to firedamp
Gases	
II	Equipment group: All except mining
3G	Category 3 (Zone 2)
Ex	Explosion protection mark
nA Gc	Type of protection and equipment protection level (EPL): Non-sparking equipment
nC Gc	Type of protection and equipment protection level (EPL): Sparking apparatus with protected contacts. A device which is so constructed that the external atmosphere cannot gain access to the interior
IIC	Explosion group of gas and vapours
T4	Temperature class: Max. surface temperature 135°C

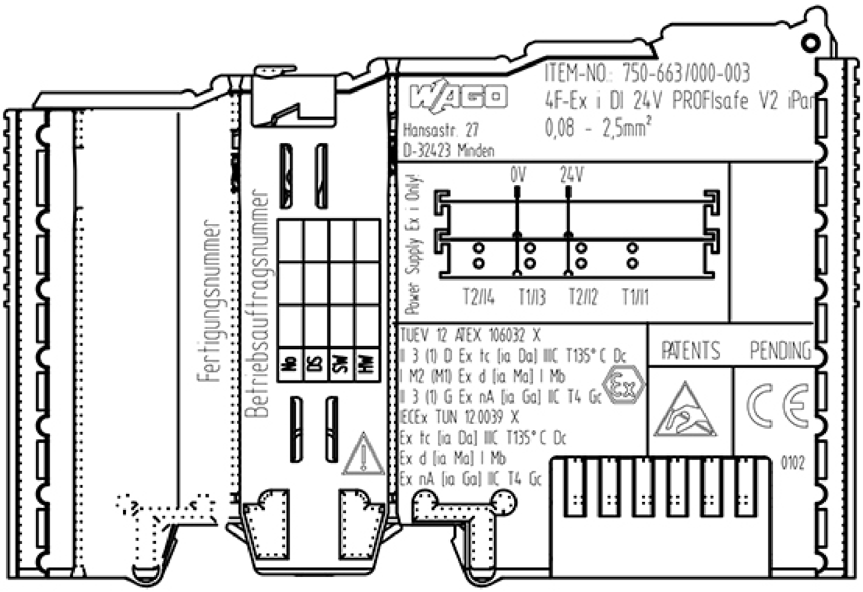


Figure 32: Side Marking Example for Approved Ex i I/O Modules According to ATEX and IECEx.

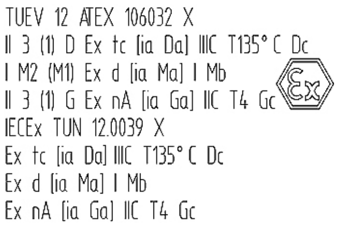


Figure 33: Text Detail – Marking Example for Approved Ex i I/O Modules According to ATEX and IECEx.

Table 35: Description of Marking Example for Approved Ex i I/O Modules According to ATEX and IECEx

Inscription Text	Description
TÜV 07 ATEX 554086 X IECEx TUN 09.0001X TÜV 12 ATEX 106032 X IECEx TUN 12.0039 X	Approving authority and certificate numbers
Dust	
II	Equipment group: All except mining
3(1)D	Category 3 (Zone 22) equipment containing a safety device for a category 1 (Zone 20) equipment
3(2)D	Category 3 (Zone 22) equipment containing a safety device for a category 2 (Zone 21) equipment
Ex	Explosion protection mark
tc Dc	Type of protection and equipment protection level (EPL): protection by enclosure
[ia Da]	Type of protection and equipment protection level (EPL): associated apparatus with intrinsic safety circuits for use in Zone 20
[ib Db]	Type of protection and equipment protection level (EPL): associated apparatus with intrinsic safety circuits for use in Zone 21
IIIC	Explosion group of dust
T 135°C	Max. surface temperature of the enclosure (without a dust layer)
Mining	
I	Equipment Group: Mining
M2 (M1)	Category: High level of protection with electrical circuits which present a very high level of protection
Ex d Mb	Explosion protection mark with Type of protection and equipment protection level (EPL): Flameproof enclosure
[ia Ma]	Type of protection and equipment protection level (EPL): associated apparatus with intrinsic safety electrical circuits
I	Explosion group for electrical equipment for mines susceptible to firedamp

Table 35: Description of Marking Example for Approved Ex i I/O Modules According to ATEX and IECEx

Gases	
II	Equipment group: All except mining
3(1)G	Category 3 (Zone 2) equipment containing a safety device for a category 1 (Zone 0) equipment
3(2)G	Category 3 (Zone 2) equipment containing a safety device for a category 2 (Zone 1) equipment
Ex	Explosion protection mark
nA Gc	Type of protection and equipment protection level (EPL): Non-sparking equipment
[ia Ga]	Type of protection and equipment protection level (EPL): associated apparatus with intrinsic safety circuits for use in Zone 0
[ia Gb]	Type of protection and equipment protection level (EPL): associated apparatus with intrinsic safety circuits for use in Zone 1
IIC	Explosion group of gas and vapours
T4	Temperature class: Max. surface temperature 135°C

11.1.2 Marking for America According to NEC 500

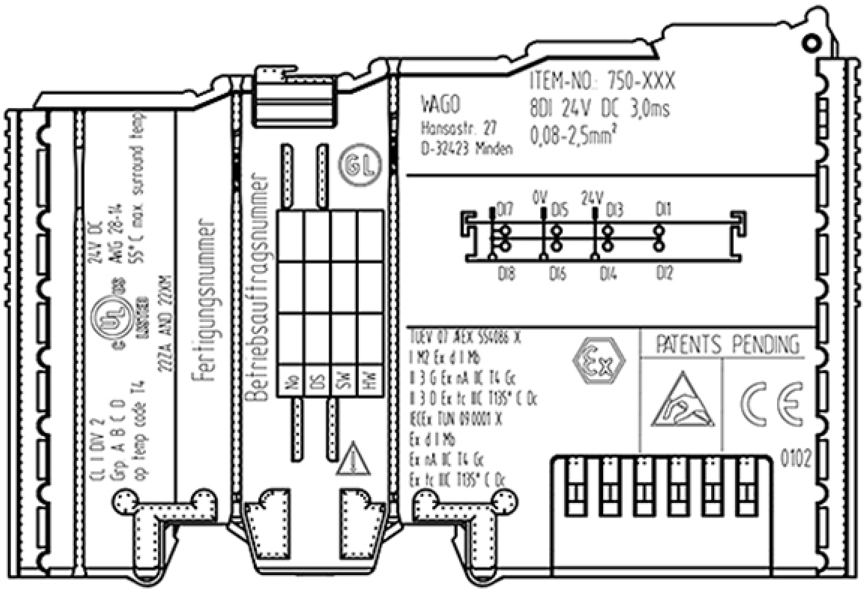


Figure 34: Side Marking Example for I/O Modules According to NEC 500

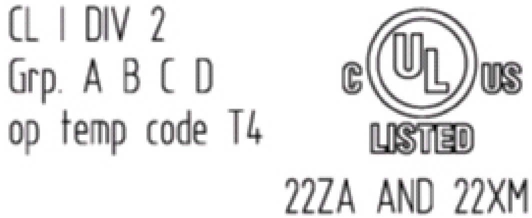


Figure 35: Text Detail – Marking Example for Approved I/O Modules According to NEC 500

Table 36: Description of Marking Example for Approved I/O Modules According to NEC 500

Printing on Text	Description
CL I	Explosion protection group (condition of use category)
DIV 2	Area of application
Grp. ABCD	Explosion group (gas group)
Op temp code T4	Temperature class

11.2 Installation Regulations

For the installation and operation of electrical equipment in hazardous areas, the valid national and international rules and regulations which are applicable at the installation location must be carefully followed.

11.2.1 Special Conditions for Safe Use (ATEX Certificate TÜV 07 ATEX 554086 X)

1. For use as Gc- or Dc-apparatus (in zone 2 or 22) the Field bus Independent I/O Modules WAGO-I/O-SYSTEM 750-*** shall be erected in an enclosure that fulfils the requirements of the applicable standards (see the marking) EN 60079-0, EN 60079-11, EN 60079-15 and EN 60079-31.
   For use as group I electrical apparatus M2 the apparatus shall be erected in an enclosure that ensures a sufficient protection according to EN 60079-0 and EN 60079-1 and the degree of protection IP64.
   The compliance of these requirements and the correct installation into an enclosure or a control cabinet of the devices shall be certified by an ExNB.
2. Measures have to be taken outside of the device that the rating voltage is not being exceeded of more than 40 % because of transient disturbances.
3. Dip-switches, binary-switches and potentiometers, connected to the module may only be actuated when explosive atmosphere can be excluded.
4. The connecting and disconnecting of the non-intrinsically safe circuits is only permitted during installation, for maintenance or for repair purposes. The temporal coincidence of explosion hazardous atmosphere and installation, maintenance resp. repair purposes shall be excluded.
   This is although and in particular valid for the interfaces “Memory-Card”, “USB”, “Fieldbus connection”, “Configuration and programming interface”, “antenna socket”, “D-Sub”, “DVI-port” and the “Ethernet interface”. These interfaces are not energy limited or intrinsically safe circuits. An operating of those circuits is in the behalf of the operator.
5. For the types 750-606, 750-625/000-001, 750-487/003-000, 750-484 and 750-633 the following shall be considered: The Interface circuits shall be limited to overvoltage category I/II/III (non mains/mains circuits) as defined in EN 60664-1.
6. For replaceable fuses the following shall be considered: Do not remove or replace the fuse when the apparatus is energized.
7. The following warnings shall be placed nearby the unit:
   WARNING – DO NOT REMOVE OR REPLACE FUSE WHEN ENERGIZED
   WARNING – DO NOT SEPARATE WHEN ENERGIZED
   WARNING – SEPARATE ONLY IN A NON-HAZARDOUS AREA

11.2.2 Special Conditions for Safe Use (ATEX Certificate TÜV 12 ATEX 106032 X)

1. For use as Gc- or Dc-apparatus (in zone 2 or 22) the Field bus Independent I/O Modules WAGO-I/O-SYSTEM 750-*** Ex i shall be erected in an enclosure that fulfils the requirements of the applicable standards (see the marking) EN 60079-0, EN 60079-11, EN 60079-15 and EN 60079-31.
   For use as group I electrical apparatus M2 the apparatus shall be erected in an enclosure that ensures a sufficient protection according to EN 60079-0 and EN 60079-1 and the degree of protection IP64.
   The compliance of these requirements and the correct installation into an enclosure or a control cabinet of the devices shall be certified by an ExNB.
2. Measures have to be taken outside of the device that the rating voltage is not being exceeded of more than 40 % because of transient disturbances.
3. The connecting and disconnecting of the non-intrinsically safe circuits is only permitted during installation, for maintenance or for repair purposes. The temporal coincidence of explosion hazardous atmosphere and installation, maintenance resp. repair purposes shall be excluded.
4. For the type the following shall be considered: The Interface circuits shall be limited to overvoltage category I/II/III (non mains/mains circuits) as defined in EN 60664-1.

11.2.3 Special Conditions for Safe Use (IEC-Ex Certificate TUN 09.0001 X)

1. For use as Gc- or Dc-apparatus (in zone 2 or 22) the Field bus Independent I/O Modules WAGO-I/O-SYSTEM 750-*** shall be erected in an enclosure that fulfils the requirements of the applicable standards (see the marking) IEC 60079-0, IEC 60079-11, IEC 60079-15 and IEC 60079-31. For use as group I electrical apparatus M2 the apparatus shall be erected in an enclosure that ensures a sufficient protection according to IEC 60079-0 and IEC 60079-1 and the degree of protection IP64.
   The compliance of these requirements and the correct installation into an enclosure or a control cabinet of the devices shall be certified by an ExCB.
2. Measures have to be taken outside of the device that the rating voltage is not being exceeded of more than 40 % because of transient disturbances.
3. DIP-switches, binary-switches and potentiometers, connected to the module may only be actuated when explosive atmosphere can be excluded.
4. The connecting and disconnecting of the non-intrinsically safe circuits is only permitted during installation, for maintenance or for repair purposes. The temporal coincidence of explosion hazardous atmosphere and installation, maintenance resp. repair purposes shall be excluded.
   This is although and in particular valid for the interfaces “Memory-Card”, “USB”, “Fieldbus connection”, “Configuration and programming interface”, “antenna socket”, “D-Sub”, “DVI-port” and the “Ethernet interface”. These interfaces are not energy limited or intrinsically safe circuits. An operating of those circuits is in the behalf of the operator.
5. For the types 750-606, 750-625/000-001, 750-487/003-000, 750-484 and 750-633 the following shall be considered: The Interface circuits shall be limited to overvoltage category I/II/III (non mains/mains circuits) as defined in IEC 60664-1.
6. For replaceable fuses the following shall be considered: Do not remove or replace the fuse when the apparatus is energized.
7. The following warnings shall be placed nearby the unit:
   WARNING – DO NOT REMOVE OR REPLACE FUSE WHEN ENERGIZED
   WARNING – DO NOT SEPARATE WHEN ENERGIZED
   WARNING – SEPARATE ONLY IN A NON-HAZARDOUS AREA

11.2.4 Special Conditions for Safe Use (IEC-Ex Certificate IECEx TUN 12.0039 X)

1. For use as Gc- or Dc-apparatus (in zone 2 or 22) the Field bus independent I/O Modules WAGO-I/O-SYSTEM 750-*** Ex i shall be erected in an enclosure that fulfils the requirements of the applicable standards (see the marking) IEC 60079-0, IEC 60079-11, IEC 60079-15, IEC 60079-31.
   For use as group I electrical apparatus M2 the apparatus shall be erected in an enclosure that ensures a sufficient protection according to IEC 60079-0 and IEC 60079-1 and the degree of protection IP64.
   The compliance of these requirements and the correct installation into an enclosure or a control cabinet of the devices shall be certified by an ExCB.
2. Measures have to be taken outside of the device that the rating voltage is not being exceeded of more than 40 % because of transient disturbances.
3. The connecting and disconnecting of the non-intrinsically safe circuits is only permitted during installation, for maintenance or for repair purposes. The temporal coincidence of explosion hazardous atmosphere and installation, maintenance resp. repair purposes shall be excluded.
4. For the type the following shall be considered: The Interface circuits shall be limited to overvoltage category I/II/III (non mains/mains circuits) as defined in IEC 60664-1.

11.2.5 Special Conditions for Safe Use According to ANSI/ISA 12.12.01

A. “This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only.”
B. “This equipment is to be fitted within tool-secured enclosures only.”
C. “WARNING Explosion hazard - substitution of components may impair suitability for Class I, Div. 2.”
D. “WARNING – Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous” has to be placed near each operator accessible connector and fuse holder.
E. When a fuse is provided, the following information shall be provided: “A switch suitable for the location where the equipment is installed shall be provided to remove the power from the fuse.”
F. For devices with EtherCAT/Ethernet connectors “Only for use in LAN, not for connection to telecommunication circuits.”
G. “WARNING - Use Module 750-642 only with antenna module 758-910.”
H. For Couplers/Controllers and Economy bus modules only: The instructions shall contain the following: “The configuration interface Service connector is for temporary connection only. Do not connect or disconnect unless the area is known to be non-hazardous. Connection or disconnection in an explosive atmosphere could result in an explosion.”
I. Modules containing fuses only: “WARNING - Devices containing fuses must not be fitted into circuits subject to over loads, e.g. motor circuits.”
J. Modules containing SD card reader sockets only: “WARNING - Do not connect or disconnect SD-Card while circuit is live unless the area is known to be free of ignitable concentrations of flammable gases or vapors.”

Information

Additional Information
Proof of certification is available on request.
Also take note of the information given on the operating and assembly instructions.
The manual, containing these special conditions for safe use, must be readily available to the user.

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