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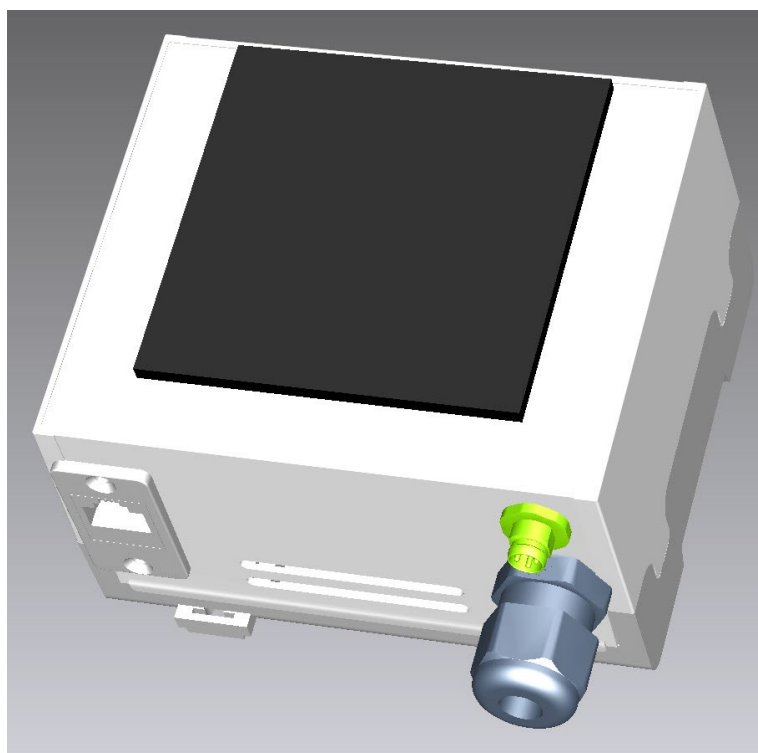
DC-Wattmeter



ADIRO

MPS- PA

Operating instructions



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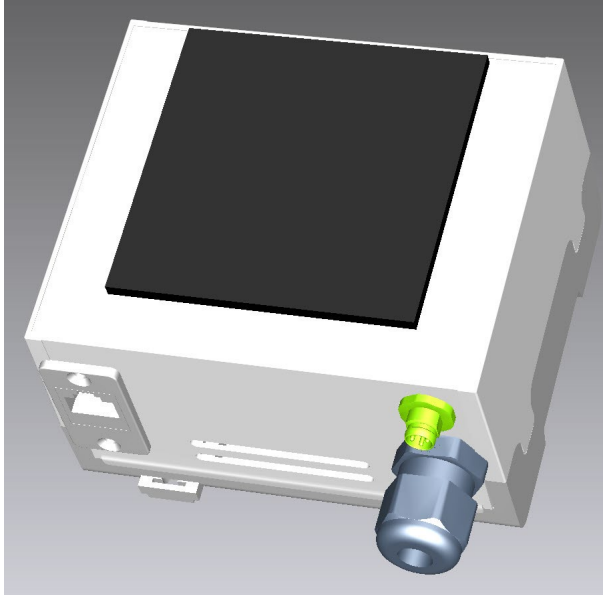
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1 Introduction

The DC Wattmeter makes it possible to measure power consumed by end users for the purpose of examination, analysis and optimisation of existing systems and their components.



The DC Wattmeter (573261) provides you with a suitable training device, by means of which the following key qualifications can be imparted in a practice-oriented manner:

- Social competence
- Technical competence
- Methodological competence

Furthermore, teamwork, willingness to cooperate and organisational skills can be imparted as well.

Realistic project phases can be trained during the course of learning projects. These include:

- Planning
- Commissioning
- Operation
- Maintenance
- Troubleshooting

1.1 Training content

Training goals can be pursued in the following areas:

- Electrical engineering
 - Definition and use of the term “electrical power”
 - Determination of a system’s efficiency
 - Identification of electrical work (energy) as a time-dependent quantity and a cost factor
 - Evaluation of electrical devices on the basis of power
 - Evaluation of standby power of individual devices
 - Correct wiring of electrical components
 - Background information on measuring technology, e.g. voltage error circuits
- Commissioning
 - Starting up a measuring device
 - Starting up a TCP/IP link
- Programming
 - Digitisation and signal sampling of analogue quantities
 - Conversion and calculation of measured values and physical quantities
 - Summation of measured quantities
 - Data communication via TCP-IP protocol
- Troubleshooting
 - Systematic troubleshooting for technical devices

1.2 Important information

Fundamental prerequisites for safe use and trouble-free operation of the DC Wattmeter include knowledge of basic safety precautions and safety regulations.

This manual includes the most important instructions for safe use of the device.

In particular, the safety precautions must be adhered to by all persons who work with this device.

Beyond this, all pertinent accident prevention rules and regulations, which are applicable at the respective location of use, must be adhered to.

1.3 Obligations of the operating company

The operating company undertakes to allow only those persons to work with the DC Wattmeter who:

- Are familiar with the basic regulations regarding work safety and accident prevention and have been instructed in the use of the DC Wattmeter
- Have acknowledged by signature the fact that they have read and understood the chapter concerning safety, and the warnings in these operating instructions

Personnel must be tested at regular intervals for safety-conscious work habits.

1.4 Obligations of the trainees

All persons who have been entrusted to work with the DC Wattmeter undertake to complete the following steps before beginning work:

- Familiarise themselves with the basic regulations regarding work safety and accident prevention
- Acknowledge by signature the fact that they have read and understood the chapter concerning safety, and the warnings in these operating instructions

1.5 Dangers involved in working with the learning system for process automation

The DC Wattmeter is laid out in accordance with the state-of-the-art, as well as recognised safety rules. Nevertheless, life and limb of the user and third parties may be endangered, and the machine or other property may be damaged during its use.

The DC Wattmeter may only be used:

- For its intended purpose
- When its safety functions are in flawless condition



Faults which may impair safety must be eliminated immediately!

1.6 Guarantee and liability

Our "general terms and conditions of sale and delivery" are always applicable. These are made available to the operating company no later than upon conclusion of the sales contract. Guarantee and liability claims resulting from personal injury and/or property damage are excluded if they can be traced back to one or more of the following causes:

- Use of the machine for other than its intended purpose
- Improper installation, commissioning, operation and/or maintenance of the machine
- Operation of the machine with defective safety equipment, or with improperly attached or non-functional safety and protective equipment
- Non-compliance with directions included in the operating instructions with regard to transport, storage, installation, start-up, operation, maintenance and setup of the machine
- Unauthorized modifications to the machine
- Inadequate monitoring of machine components which are subject to wear
- Improperly executed repairs
- Disasters resulting from the influence of foreign bodies and acts of God

ADIRO hereby excludes all liability for damage suffered by the trainee, the training company and/or any other third parties as a result of use of the system outside a purely training situation, unless ADIRO has caused this damage wilfully or through gross negligence.

1.7 Use for intended purpose

Intended use

- Measurement and display of direct voltage, direct current and power of DC consuming devices
- Read-out of power values at the signal outputs based on standard signals of 0 to 10 V or 4 to 20 mA
- Maximum measuring range of 0 to 120 W at max. 30 V direct voltage or 5 A direct current

Operation is only permissible with 24 V DC supply voltage. Measuring ranges can be selected by means of a DIP switch.

The measuring device may not be operated if it has been opened up. Measurements in damp locations or under adverse ambient conditions are impermissible.

Adverse ambient conditions include:

- Moisture or high atmospheric humidity
- Dust and flammable gases, vapours or solvents
- Thunderstorms or thunderstorm conditions such as powerful electrostatic fields etc.

Use for any purpose other than those described above results in damage to the product, and is also associated with hazards such as short-circuiting, fire, electrical shock etc. The product may not be changed or modified!

Under no circumstances may the specified maximum permissible input quantities be exceeded. Do not touch any circuits or circuit components if they carry voltage exceeding 25 V AC or 35 V DC.

Make sure that the ventilation slots are not blocked and that sufficient air can circulate. Make sure that the ventilation slots are free of dust and dirt to prevent overheating.

The safety instructions must be adhered to unconditionally!

2 Safety instructions

2.1 General



- Trainees may only work with the device under the supervision of a trainer.
- Observe specifications included in the technical data for the individual components, and in particular all safety instructions!

2.2 Electrical functions

Attention



- Electrical connections may only be established and interrupted in the absence of voltage!
- Use only extra-low voltage (max. 24 V DC) as supply power for the DC Wattmeter.
- When connecting consuming devices to the DC Wattmeter, use a power pack with no more than 24 V DC and a maximum load current of 5 A.
- Incorrect use of this measuring device may result in damage, electrical shock, injury and danger to life and limb. Read and understand these operating instructions prior to commissioning.
- Before replacing the fuse, the measurement cables and connector cables must first be disconnected.
- Inspect the measurement cables and the measuring device for possible damage before use. Arrange to have any damage repaired, or damaged parts replaced, before using the device.
- If the device is used for any purposes other than those specified by the manufacturer, the safety equipment included in the device might be rendered inoperative.
- This device is not a toy and must be kept out of the reach of children. It contains dangerous objects and small parts which must not under any circumstances be swallowed by children. If any such parts should nevertheless be swallowed by a child, contact a physician immediately.
- Do not leave the packaging materials unattended. They can be dangerous for children if misused as toys.
- The operating instructions must be read in their entirety prior to commissioning. In the event of damage or consequential damages due to non-observance of the operating instructions, the guarantee is rendered null and void and no liability is assumed.
- The DC consumer must be de-energised and correctly connected – check wiring carefully before starting up the measuring device.

Protective input limits

This measuring device has been developed for safe use, but it must nevertheless be handled with care. The following stipulations must be adhered to in order to assure safe handling.

Never apply voltage or current to the measuring device which exceeds the specified maximum value:

Technical data of the consuming device	
Max. measuring voltage	30 V DC
Max. measuring current	5 A

* Large measuring range selected via DIP switch ("**" appears in the top line of the display)

Electrical protection class

The DC Wattmeter works with safety extra-low voltage (SELV) of less than 50 V, and is therefore a protection class III device per DIN EN 61140 (VDE 0140-1).



SELV involves a small electrical voltage which assures exceptional protection against electrical shock thanks to its minimal value and circuit separation in comparison with electrical circuits with higher voltages.

Devices operated with SELV, and which do not themselves generate any higher voltages, are designated protection class III devices in accordance with DIN EN 61140 (VDE 0140-1).

Voltage is so small that electrical shock currents normally have no consequences at all. The voltage source can be either a generator, for example a bicycle dynamo, or a battery.

Otherwise, special requirements for separation from parts which conduct mains voltage (e.g. the primary coil of a transformer) must be adhered to, which are known as protective separation.

SELV voltage sources in accordance with EN 60960 are not equipped with a protective earth conductor. Metallic housings must not be earthed.

3 Technical data

Parameter	Value
Display	LCD graphic display 192x160 pixels, 16 grey levels with RGB backlight illuminated area: 55 x 46 mm active area: 50 x 42 mm
Indicating range Momentary power Total consumption	0.0 to 120.0 W 0.001 to 9999999,9 Wh
Operating voltage	24 V DC ($\pm 10\%$)
Internal consumption	2.4 W
Measurement input Max. short circuit current. polarity reversal protection Short-circuit protection	200 mA No reverse polarity protection, measurement of negative and positive voltages Fuse, medium time-lag (M) 6.3 A
Measurement input resolution Current measurement 0 to 5.0 A Voltage measurement 0 to 30V	15 bit (without leading sign), can be switched with jumper ~ 0.2 mA / bit 15 bit (without leading sign) ~ 1 mV / bit
Measurement input accuracy Current measurement 0 to 5.0 A Voltage measurement 0 to 30 V Power measurement 0 to 120 W	$\pm 1\%$ FS (Resistance 5 m Ω) $\pm 1\%$ FS (Impedance 2.6 M Ω) $\pm 1\%$ FS
Sampling rate	200 ms
Signal outputs Electrical output Output resolution	Voltage output 0-10 V 12 bit
Housing Type Material, housing Material, top	Rail mount housing Polycarbonate, green Polycarbonate, transparent
Dimensions (W x H x D)	107 x 90x 63 mm
Weight	330 g
Communication interfaces	Ethernet TCP, V4, configuration via Software FluidLab energy V2.0

4 Transport, unpacking, scope of delivery, disposal

4.1 Transport

The DC Wattmeter is shipped in a carton.

The carton must be secured against drops and falling.

The freight forwarder and the supplier must be notified of any transport damage without delay.

4.2 Unpacking

Examine the DC Wattmeter for possible damage after unpacking.

The freight forwarder and the supplier must be notified of any damage without delay.

4.3 Scope of delivery

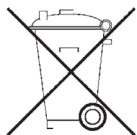
The following components are included in the scope of delivery:

- DC Wattmeter
- Connecting cables for supply power and consuming devices
- Connecting cable for analogue signal, 2.5 m, with M8 3pol connector.
- Ethernet cable, 2 m, RJ 45, CAT5
- CD-ROM with technical documentation and software:
 - Operating instructions for the DC Wattmeter
 - Data sheet for the DC Wattmeter
 - Software © FluidLab energy V2.0

Check delivered items against the packing slip and your purchase order.

The supplier must be notified of any deviations without delay.

4.4 Disposal



Waste electronic equipment contains recyclable materials and should not be thrown away with the rubbish. When the device has reached the end of its service life, dispose of it in accordance with applicable regulations at a municipal collection centre.

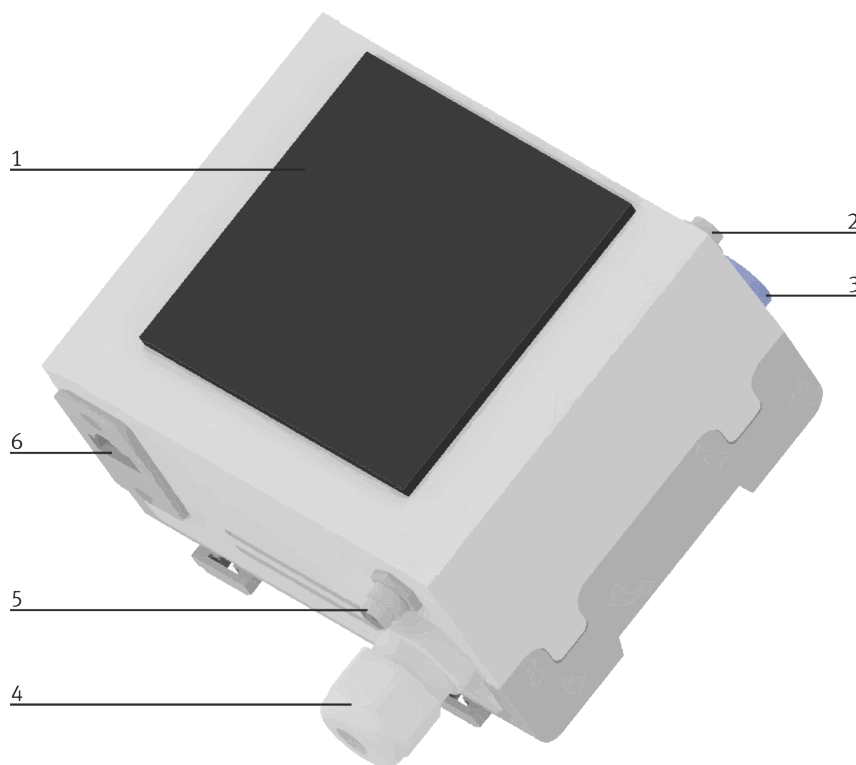
Disposal with the rubbish is prohibited.

5 Layout and function

The DC Wattmeter consists of the following individual components:

- Multifunctional measuring device with LCD and interfaces in the top-hat rail housing
- Connection cable with 4 mm laboratory graded safety sockets for power supply and load

5.1 Setup, display and electrical connections



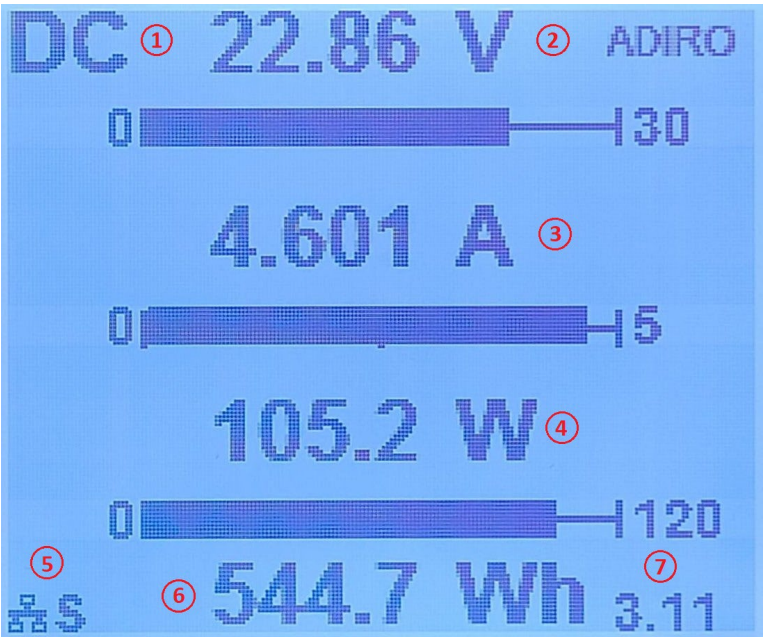
Block diagram of the DC Wattmeter

Legende

Position	Bauteil	Funktion
1	DC-Wattmeter	Multifunktions-Leistungsmessgerät
2	Reset Taster	Taster zum Nullen des Gesamt-Energie-Verbrauchs
3	Sicherungshalter mit Schmelzsicherung	G-Sicherungseinsätze 5x20mm Mittelträge 6,3 A C
4	Kabeleinführung	Anschlussleitung mit 4mm Laborsteckern Rot = 24 VDC / Blau = 0V DC für Netzteil und Verbraucher
5	M8 Stecker 4-polig	Leistungswert 0-120 W als Analogausgabe 0-10V, Pinbelegung: 1 BN n.c. 2 WH Analog 0-10V 3 BU 0V 4 BK n.c.
6	RJ45-Buchse	Kommunikations-Schnittstelle für Ethernet, mit integrierten Anzeige LEDs

5.2 Display

The size of the DC Wattmeter’s LCD has 192x160 pixel. The display is divided in subareas with different topics, as shown in the following picture.



DC Wattmeter: Display values

Display	Function
1.	Electrical voltage type
2.	Current voltage 0 to 30 volts
3.	Current eletrical current 0 to 5 Ampere
4.	Current energy 0 to 120 Watt
5.	Network connection
6.	Current energy cunsumption in Wh
7.	Firmware version

The listed voltage, current and energy values are also displayed via a bar graph below the corresponding values. The current energy consumption is recorded with an attached load from the time the device is switched on or after it is connected to a load. The energy consumption can be reset using the button on the top of the device or in the software, © FluidLab energy V2.0.

If the device is connected via ethernet, this is indicated by the connection symbol in display on point 5 and is not crossed out. The connection type is static, which can be recognized by the letter “S” behind the connection symbol. The firmware version of the device can be read via the point 7 on the display. If errors or problems occur, the current firmware version must be stated in the error description.

5.3 Fuse

A fuse holder is installed on the top of the housing to protect the meter against overcurrents; please use the following fuse element:

- G-fuse link 5x20 mm 6.3 A, medium time-lag



The housing of the DC Wattmeter is only to be opened by trained and qualified personnel!

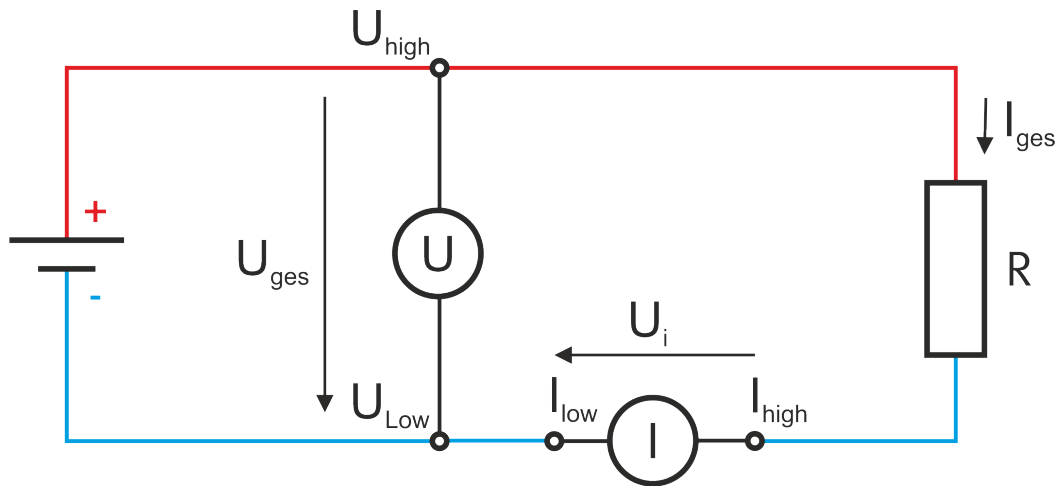
5.4 Measurement inputs

■ Voltage measurement

Voltmeters are used to measure electrical voltage. The voltmeter is connected in parallel to the consuming device (R). In the case of digital voltmeters, internal resistance is usually within a range of 1 to 10

■ Voltage measuring circuit

With the voltage measuring circuit, a voltage divider is created consisting of the internal resistance of the ammeter and the resistance to be measured. Voltage drop at the amp meter distorts the voltage measurement. Measured voltage U_{total} is too high by an amount equal to voltage U_i .



Voltage error circuit

■ Performance

The DC Wattmeter calculates the power in a display range of 0 to 120 W from the measurements of current in the 0 to 5 A measuring range and voltage in the 0 to 30 V measuring range.

5.5 Analogue outputs

The DC Wattmeter has an analog output with the standard signal voltage 0 to 10 V.
The voltage of 0 to 10 V is output in a range of 0 to 120 W depending on the power level.

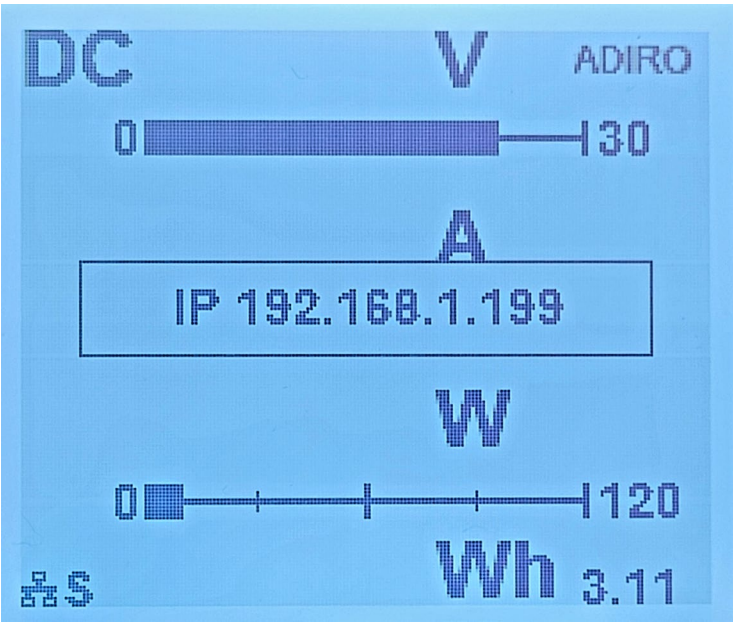
Current	Calculated/displayed power
0 V	0 W
1 V	12 W
5 V	60 W
7 V	84 W
10 V	120 W

5.6 Ethernet interface

For the ethernet interface of the DC Wattmeter, data is exchanged via th TCP/IP protocol.
The ethernet interface is a modular communication board with the following properties:

- Supports ethernet TCP/IP protocols V4
- Max. 1024 bytes of input data and 1024 bytes of output data

The default IP address of the DC-Wattmeter is: 192.168.1.199. The current IP address is shown on the display of the DC-Wattmeter for a period of 5 seconds after the first connection to a power supply unit, as shown in the following illustration.



DC Wattmeter: Display of the IP address during the boot process

Communication between the DC Wattmeter and ethernet can be established via the software © FluidLab energy V2.0 or via a direct TCP client connection. The DC Wattmeter sends a message every 200 ms with the current measured values with a length of ~ 102 bytes (the length depends on the TCP checksum or the counter value of the message). The structure of each message is as follows (with line break):

```
value:0;172;25625;0;22.846
value:0;54;25625;1;4.411
value:0;17;25625;2;100.780
value:0;26;25625;3;687.498
```

The messages are already automatically processed and displayed in the © FluidLab energy V2.0 software, but can also be read out by the user if the TCP messages are processed accordingly. The structure of the message will be explained below to help you process the TCP communication yourself.

■ TCP message

A TCP message contains all the display values of the DC Wattmeter. The first line of a TCP message is explained as an example to illustrate this:

```
value:0;172;25625;0;22.846
```

Each value begins with a value: followed by a message ID (set to 0), a TCP checksum and a TCP message counter of the device. The 4th number of a message represents the following display values:

- 0: Voltage
- 1: Current
- 2: Energy
- 3: Energy consumption

The 5th number transmits the measured value, with a resolution of three decimal places.

Translated with DeepL.com (free version)

6 Commissioning

The DC Wattmeter calculates the current power of a consumer from current and voltage measurements.

The DC Wattmeter can be used in various learning scenarios:

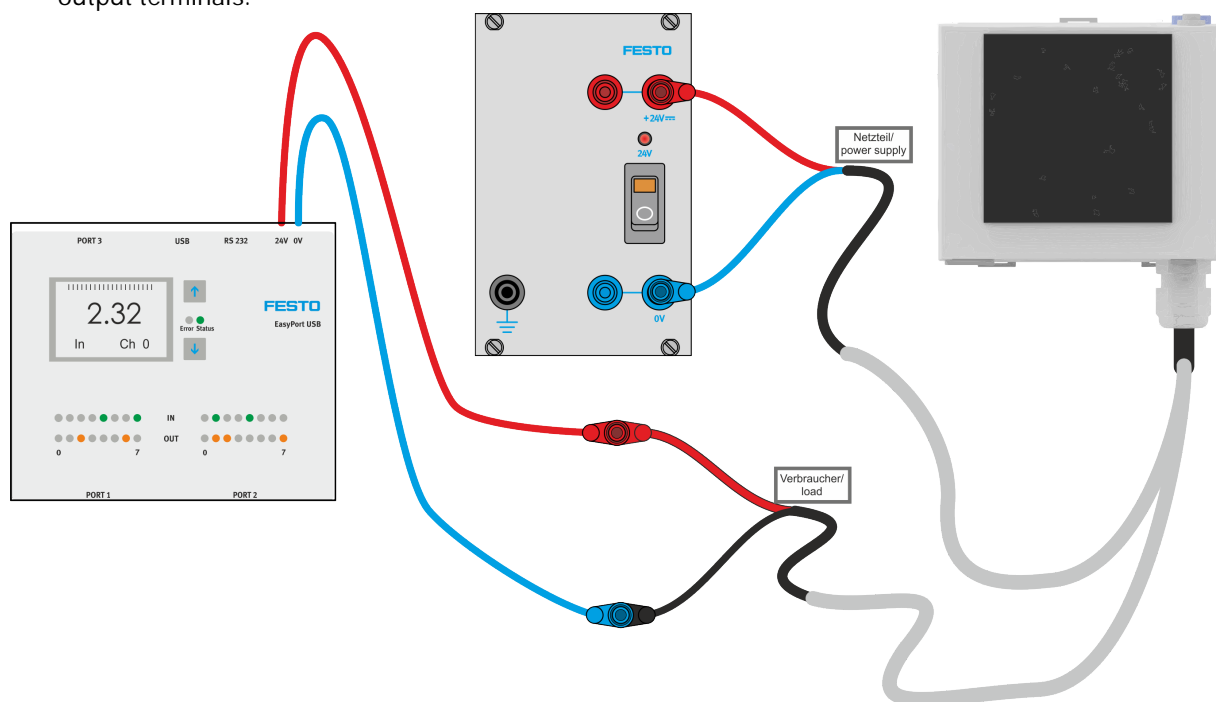
- Determining the energy consumption of an individual consumer
- Determining the energy consumption of a station or system

The electrical power consumption of a station or system, e.g. EduKit-PA, is to be determined. To do this, the DC Wattmeter is connected between the power supply unit (supply) and the station (consumer). Each MPS/MPS-PA station or EduKit PA is supplied via the control unit. A simulation box, Easyport, PLC board or EduTrainer can be used as the controller. In the following example, an Easyport is used as the control unit. The connection is made with 4mm safety laboratory plugs.

6.1 Connecting the DC Wattmeter to loads

To measure voltage, current and power in a DC circuit, the following steps must be followed:

1. Switch off the power supply unit/supply to the body. Only make connections in a de-energized state. Use a supply with max. 24 V DC and 5 A. 2.
2. connect the load with the marked 4 mm safety laboratory plug "load". Observe the correct polarity.
3. connect the supply/power supply unit with the marked 4mm safety laboratory plug "Supply/supply". Observe the correct polarity.
4. check the measuring circuit.
5. switch on the power supply unit/supply of the set-up. The DC Wattmeter
6. the current power value can now be recorded or further processed at the output voltage or current output terminals.



Example for the connection of the DC Wattmeter

6.2 Connecting the DC Wattmeter to the Ethernet network

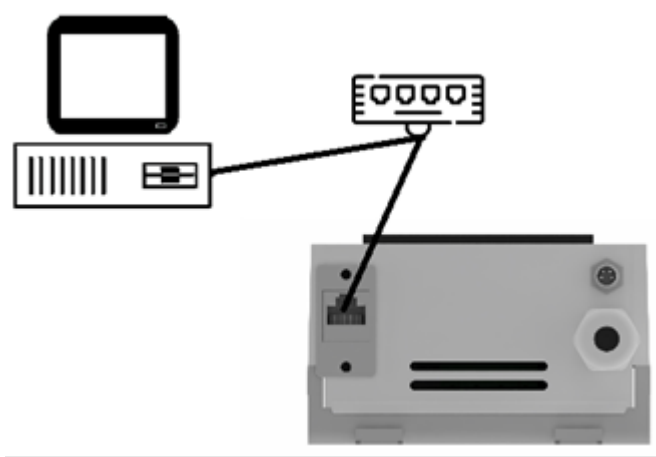


Caution: All components should be switched off when connecting!

There are two ways to connect the PC to the DC Wattmeter with Ethernet interface:

Connection via a hub or switch

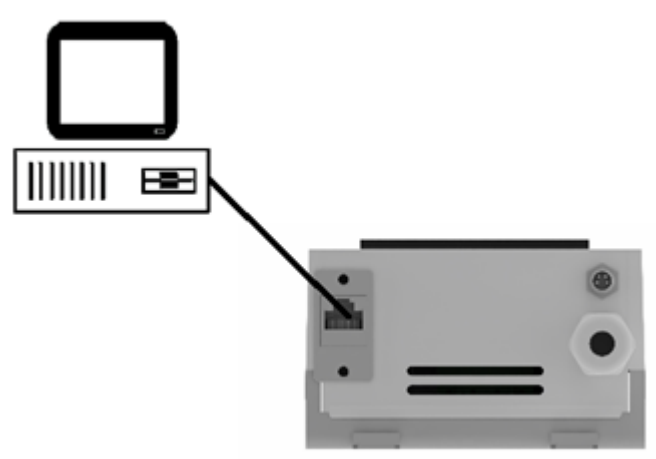
Connect the network participants as follows:



Both the PC and the DC Wattmeter are connected to the hub via a patch cable. The patch or Ethernet cable is included with the DC Wattmeter.

Direct connection to the PC

The PC is connected directly to the DC Wattmeter with Ethernet interface via a crossover patch cable.



Connect the RJ45 connections of the PC and DC Wattmeter with the crossover patch cable. A crossed patch cable is used to establish a point-to-point connection that cannot be extended.

Once the devices are connected, the PC can be switched on and the DC Wattmeter can be supplied with power.

Testing the Ethernet connection within the network

If the DC Wattmeter with Ethernet interface has been connected to the PC as described above, testing can be conducted in order to determine whether or not setting of the IP address at the PC was successful, and if data transmission via Ethernet is possible.

An IP address is normally described in four decimal blocks, for example 192.168.1.235. Each block is summarised in 8 bits. This results in a value range of 0 to 255 for each block.

The IP address of the PC must be within the IP address range of the DC Wattmeter, i.e. the first 3 blocks must be the same. The default setting for the DC Wattmeter specifies a fixed address range of "192.168.1.XXX" in the first 3 address blocks.

Open a command window at the PC in order to check the address (in Windows XP: start -> run -> cmd).

The PC's IP address can then be determined by executing the "ipconfig" DOS command.

```

C:\WINDOWS\system32\cmd.exe
C:\Dokumente und Einstellungen>ipconfig

Windows-IP-Konfiguration

Ethernetadapter Drahtlose Netzwerkverbindung:

    Medienstatus. . . . . : Es besteht keine Verbindung

Ethernetadapter LAN-Verbindung:

    Verbindungsspezifisches DNS-Suffix: adiro.local
    IP-Adresse. . . . . : 192.168.1.15
    Subnetzmaske. . . . . : 255.255.255.0
    Standardgateway . . . . . : 192.168.1.254

Ethernetadapter SonicWALL Virtual Adapter:

    Verbindungsspezifisches DNS-Suffix:
    IP-Adresse. . . . . : 223.1.1.128
    Subnetzmaske. . . . . : 255.255.255.0
    Standardgateway . . . . . :
  
```

Windows IP configuration for the Ethernet adapter

Nowadays, PCs are frequently equipped with several LAN or WLAN adapters. The important thing is the display of the LAN connection, e.g. 192.168.1.15.

The connection with the DC Wattmeter can then be checked with the "ping < IP address > " DOS command, for example c:\ping 192.168.1.199 < CR> .

"192.168.1.199" stands for the IP address which has been set as a factory default value for the DC Wattmeter.

The following message should be generated at the command window:

```

C:\WINDOWS\system32\cmd.exe

C:\>ping 192.168.1.199

Ping wird ausgeführt für 192.168.1.199 mit 32 Bytes Daten:

Antwort von 192.168.1.199: Bytes=32 Zeit<1ms TTL=128
Antwort von 192.168.1.199: Bytes=32 Zeit<1ms TTL=128
Antwort von 192.168.1.199: Bytes=32 Zeit<1ms TTL=128
Antwort von 192.168.1.199: Bytes=32 Zeit<1ms TTL=128

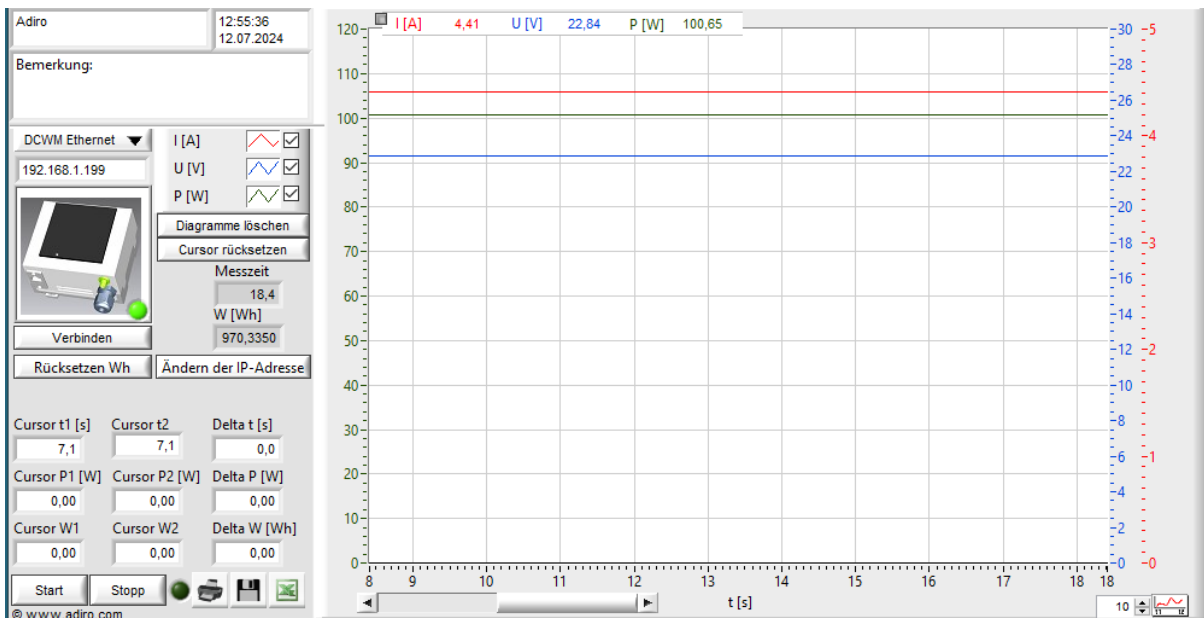
Ping-Statistik für 192.168.1.199:
    Pakete: Gesendet = 4, Empfangen = 4, Verloren = 0 (0% Verlust),
    Ca. Zeitangaben in Millisek.:
        Minimum = 0ms, Maximum = 0ms, Mittelwert = 0ms

C:\>

```

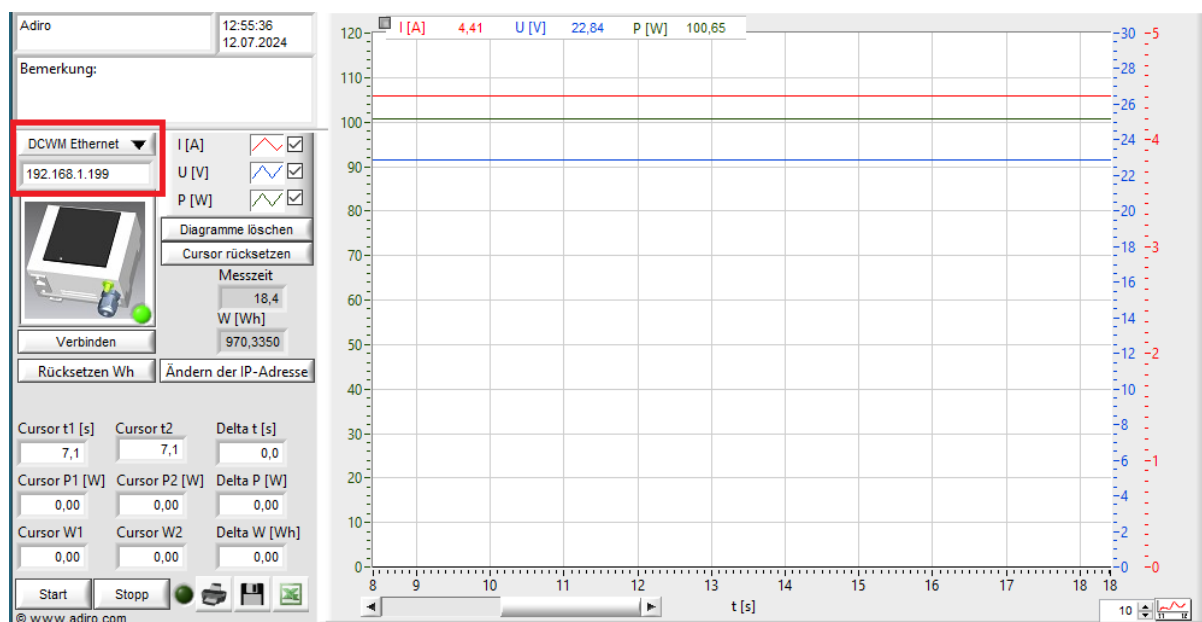
6.3 Configuring the Ethernet interface

The Ethernet interface of the DC Wattmeter can be set via the © FluidLab energy V2.0 software and the static IP address can be changed.



© FluidLab energy V2.0 visuals

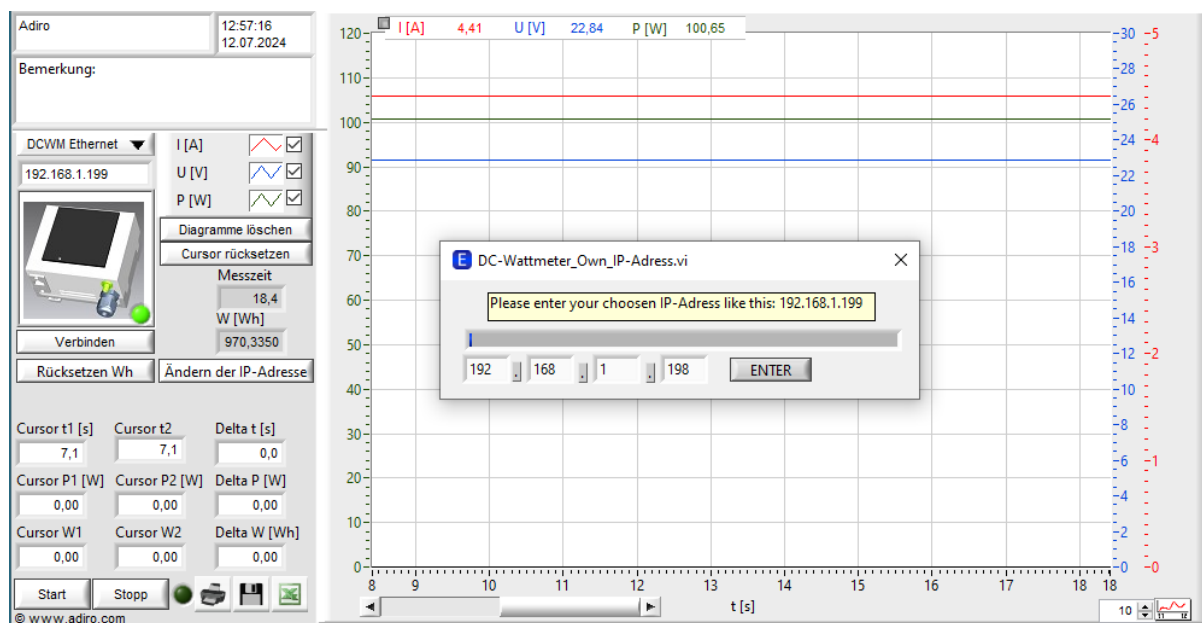
First, you should establish a connection to the device by going to the drop-down list in FluidLab energy V2.0 and selecting DCMW Ethernet. Then enter the IP address of the device, the **default address is 192.168.1.199**.



Drop-down list for the devices selection and entering the device IP address

The LED symbol at the bottom right of the DC Wattmeter image should now light up green, indicating that you have set up a connection between the software and the device.

To change the IP address, you can now click on the "Change IP address" button. You can set the new IP via a new input window.



Input prompt for a new IP-address onto your device

Once you have written the address and confirmed it with ENTER, it can be set or the process can be canceled. The set IP address is now the new device IP. **You should make a note of this and keep it in a safe place.**

7 Maintenance and troubleshooting

7.1 Maintenance



In order to avoid any danger of electrical shock, disconnect the measuring device from the 24 V DC power pack and remove the measurement or connecting cables from the terminals before opening the housing.

Do not operate the device while the housing is open. If the DC Wattmeter is handled properly, and if it is cared for in accordance with the instructions, it will provide you with many years of reliable service:

1. Keep the DC Wattmeter **dry**.
Dry it immediately if it should become wet.
2. **Use and store the device under normal temperature conditions.**
Extreme temperatures may reduce the service life of electronic devices and cause deformation or melting of plastic parts.
3. **Handle the DC Wattmeter with care.**
If the device is mechanically damaged, damage may occur to the electronic components or the housing.
4. Keep the DC Wattmeter **clean**.
Wipe it occasionally with a moist cloth. **Do not use** any aggressive chemical agents, cleaners or solvents.

7.2 Replacing the fuse



The DC Wattmeter's components are protected against overcurrent at the input side by fuse F1 (2).

Procedure for replacing the fuse:

1. Disconnect the measuring device from the 24 V DC power pack and remove the measurement or connecting cables from the terminals before opening the housing. Disconnect all electrical connections from the device.
2. Carefully remove the housing bottom. The snap hooks can be opened easily with only minimal force.
3. Carefully pull out the blown fuse (2) and insert a new 5x20 mm class G fuse for 6.3 Amp into the holder.
The new fuse must be of the same size and voltage rating as the original fuse.
4. Close the housing.



Warning: danger of electrical shock!

Do not operate the measuring device before the housing has once again be fully closed.

7.3 Eliminating malfunctions

This section describes how you can eliminate malfunctions yourself. Please adhere to applicable safety regulations.

Error	Cause	Remedy
Display does not light up, current or voltage output functions.	Incorrect brightness setting.	Turn the brightness adjusting potentiometer all the way to the left. Then turn it slowly to the right until an image appears at the display.
Display does not light up and current or voltage output does not function either.	Supply power incorrectly connected.	Reverse supply power polarity to the DC Wattmeter.
Current display always shows 0.00 A although current is present.	Consuming device incorrectly connected.	Double check your test setup.

8 Appendix

All documents are available for download as PDF files.

Data sheet 8216170 DC-Wattmeter

