Preface

This document describes the functions and the operation of the photometer analyser TMK480-CT for the detection of water in brake fluid. This analyser is based on the transmission of light through the sample. The company responsible for development, production, sales and service of photometers operated with the analyser TMK480-CT is:

PIER-ELECTRONIC GmbH
Nassaustrasse 33–35
65719 Hofheim-Wallau
Germany

Tel.: +49 – 6122 2054
Fax: +49 – 6122 16533
E-Mail: info@pier-electronic.de

Correct operation of the analyser is warranted exclusively for operation with sensors produced by PIER-ELECTRONIC GmbH.

This document contains all necessary descriptions for operation, installation, and troubleshooting.

This manual and the software are subject to technical modifications that serve, for example, the improvement of performance or to comply with regulations. If necessary, such modifications will be described in additional documentation.

This manual is subject to changes of content without notice. Information contained in this document is provided without liability for correctness. In particular, the mention of properties or characteristics in this document does not necessarily imply the existence thereof. The user of the analyser is fully responsible for all risks taken by the application of this information.

We are grateful for any hint or suggestion that helps to improve this documentation.

Important Note

Please be aware that the analyser uses a backup battery to retain important operating parameters in memory during down times.

This battery needs to be replaced once a year to prevent damage to the system, measurement failures and service deployments.

The replacement procedure is described on page 41.

General Remarks

The present manual address technically skilled staff with adequate knowledge and skills in the area of measurement and controlling technology.

Thorough familiarisation with all safety advices and warnings as well as their accurate technical realisation are a prerequisite for safe installation, implementation, operation and maintenance of devices of PIER-ELECTRONIC GmbH. It is mandatory that all procedures be conducted by qualified staff.

For reasons of readability, the present manual cannot describe all handling details in all possible application cases. Furthermore, it cannot take into account all possible configurations of installation, operation and maintenance. Please contact us and ask for addition information if needed or if you encounter specific problems not described (or described in insufficient detail) in this manual.

Ignoring the safety notes can lead to damage of equipment, injuries, or death.

This document contains the manual for the universal photometer analyser **TMK480-CT** focused on the application of detecting water in brake fluid**.**

Each device delivery includes a separate **brief description** with the following documents:

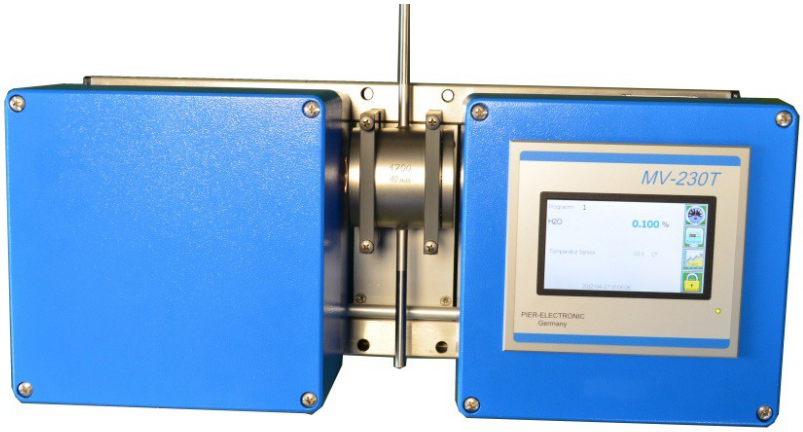
- **Data sheet**
- **Installation and start-up instructions**
- **Brief instruction**
- **Brief instruction for troubleshooting and service**

Content

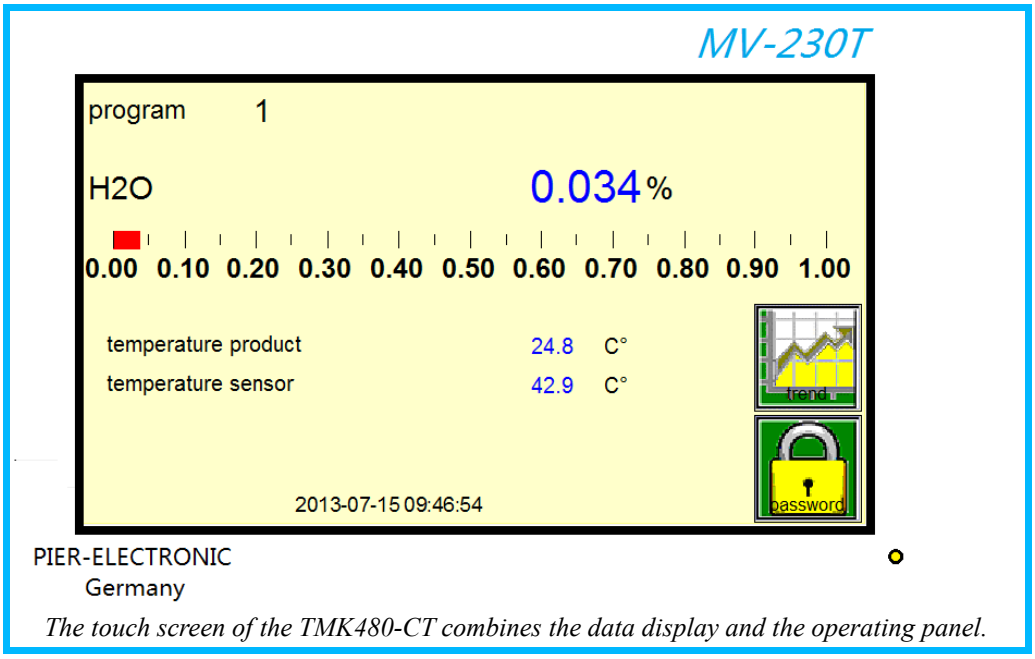
1 Basic Information

1.1 Layout

The TMK480-CT combines measurement and analysis in one device. The left compartment serves as the power and lamp housing, while the right compartment contains the receiver (light detector), the analysis electronics, and the operating panel (touch screen). The flow cell with the brake fluid runs between the two compartments:

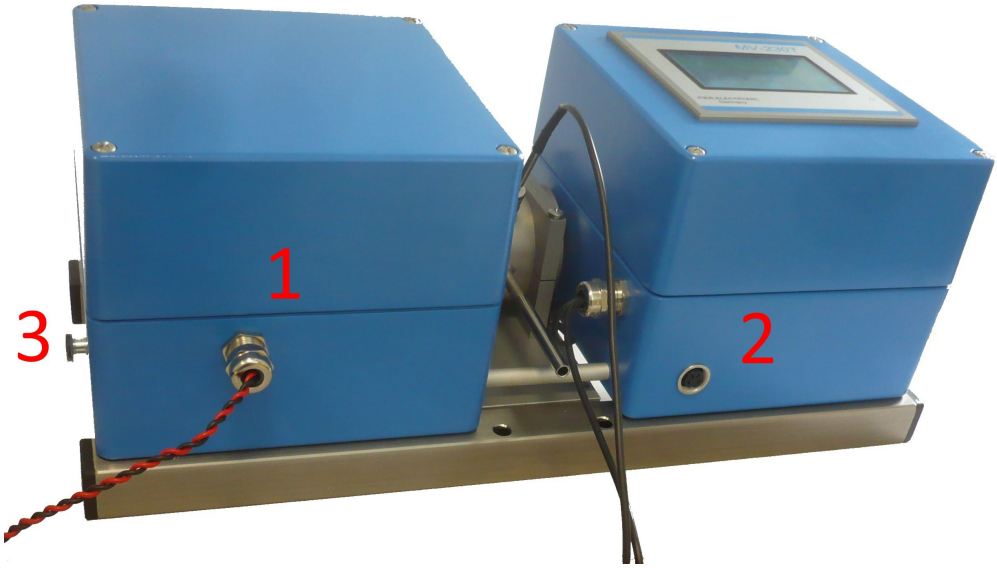


The two parts of the TMK480-CT: Left, the lamp housing; right, the receiver housing with analysis and operating unit. The brake fluid is analysed while passing through the flow cell between the two parts.



The touch screen of the TMK480-CT combines the data display and the operating panel.

The analyser has the following connectors:



Nr.	*Connector*	*Function*
1	Acc. to order	Power supply
2	4-pin female M16 jack	Analog output for measured data, 1(-) /2(+) : 4.....20 mA , max. 500 Ohm load (galvanically insulated) 3/4: not used
3	Screw	Grounding

1.2 Safety Instructions

The analyser is an electrical device for operation in industrial facilities. During operation, parts of the analyser possess dangerous electrical voltages. Incorrect handling, such as the removal of provided and necessary covers or insufficient maintenance, can lead to health-related or material damage.

Before connecting the device, it shall be verified that voltage and polarity of the power supply meet the requirements of the analyser.

During ALL works in the analyser, the sensors, or the connecting wires, the device has to be disconnected from the power supply.

The staff responsible for the safety of the installation have to ensure that

- only qualified staff are ordered to work with the device and operate it;
- those staff have access to this manual, including attachments and documentation specific to a particular installation, for all procedures. The operator of the facility obliges those staff to follow the documentation thoroughly.

Qualified personnel are meant to be skilled persons admitted by the responsible for the plant safety, to carry out work and operating measures at the equipment because of education, experience, specific instruction as well as knowledge of the relevant standards, legal regulations, accident prevention regulations and business organisation.

Furthermore, these persons are able to understand and avoid possible risks because of their qualification (definition of “skilled worker”, for example according to VDE 105 or ICE 346).

The presentation and information in this manual are to be understood as one of multiple options. In any given case, the actual applicability to the task in question has to be verified.

The contents of this manual have been worded based on the assumption that our devices will not be used in safety-related facilities or in facilities which pose a threat to life or physical condition. PIER-ELECTRONIC GmbH cannot be held responsible for the application of this device under conditions outside of those that are known to us and have not been rejected by us.

Furthermore, our general Terms and Conditions apply, as do any statements given by us in written form in the context of the processing of the order.

The preceding safety advice does not claim to be complete. The specifications in this operating manual describe the characteristics of our device without warranting them in specific cases. In case of questions or problems that are related to the operation of our products, support is available from:

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Nassaustrasse 33–35
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E-Mail: info@pier-electronic.de

We have double-checked our product, its documentation, and this operating manual thoroughly and to our best knowledge in accordance with out quality guidelines. However, there is no warranty with respect to completeness or correctness of the specifications.

1.3 Brief Description

Password protection Page 18

The display on the front panel is locked with a password to prevent erroneous inputs.

Measurement Principle

The measurement is based on the optical transmission of light at two channels (wavelengths). The moisture is detected by comparing a channel at which the water molecules strongly absorb light to a channel where they absorb no or little light. These two channels are referred to as the measurement channel and the reference channel, respectively.

Transmission (equation 1.1) is defined as the fraction of light that passes through the sample, while the remainder is scattered or absorbed:

Transmission (%)	$Tr[\%] = 100\,\% \cdot \left(\frac{P}{P_0}\right)$	(1.1)

where P_0 is the incoming intensity of light (from the lamp), and P is the intensity detected by the sensor on the other end of the sample.

The extinction, or optical thickness, which is calculated from the transmission as

Extinction (Optical Thickness)	$E = -\log\left(\frac{P_0}{P}\right) = -\log\left(\frac{100}{Tr[\%]}\right)$	(1.2)

is proportional to the absorption coefficient of the sample,which in turn is a linear function of the **concentration** of the absorbing substance (water) in the sample. The parameters of that linear function are determined by the calibration procedure, as they depend on the instrument's optics, among others.

Applying this technique to the ratio of the signals from two (or more) wavelength channels has several advantages:

- Lamp ageing (a slow decrease in light output over months) affects both channels equally, so that its impact cancels out and lamp ageing can be ignored by the user;
- 'grey' interferences, such as dirt on the lenses, cancel out as well (as long as they do not totally annihilate the light beam);
- the raw data can be normalized, which simplifies the evaluation algorithms.

Temperature Compensation Page 27

The analyser has two Pt100 channels for direct connection of temperature sensors. The measured temperatures are used to correct for deviations of the main measurement that are caused by changes of temperature: both the spectral absorption bands of the water molecules and the filter function of the spectral filters shift in wavelength when the temperature changes.

Analog Output Page 23

An analog output is available which can provide a current signal proportional to the measured data (0–20 mA or 4–20 mA). The current output is galvanically insulated.

Data Interfaces Page 30

The measured data is also available at outputs that correspond to the MODBUS and RS-485 standards. Upon request, the analyser can also be equipped with a PROFIBUS module.

Data Recording Page 33

The analyser can record the measured data in internal log files or on an external USB flash drive. The recording is independent of the analyser display.

Easy Calibration Page 14

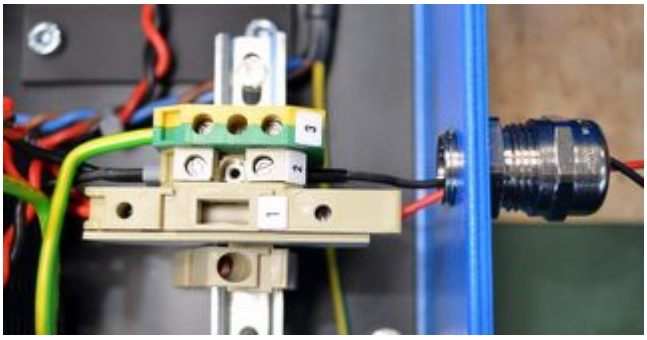
Calibration of the system is done within a few minutes. For calibration, the flow cell is replaced with calibration samples. If equipped with a mechanical switch, the system automatically switches into calibration mode (and vice versa) upon removal of the flow cell. This prevents erroneous changes of the calibration parameters. The graphic touch-screen display easily guides you through the calibration procedure.

The analyser keeps the latest three calibration parameter sets in memory. Each of them can be recovered which may be useful if something goes wrong during a re-calibration, e.g., due to operation errors or faulty calibration samples.

2 Basic Operation

2.1 Switch on

If a power supply (230 VAC to 24 VDC) is provided, connect it to the mains network. Otherwise, connect a 24 VDC (1 A) power supply to the left lamp housing of the analyser as shown in this image (the red wire at pin 1 is + while – is the black wire at pin 2; if ground is available, it can be connected to pin 3):



After the power supply has been connected and switched on, the start-up image appears on the touch screen:

After this, the systems starts (this may last up to one minute) and the following image is displayed (for about 15 seconds) before the standard data display is shown (next page).

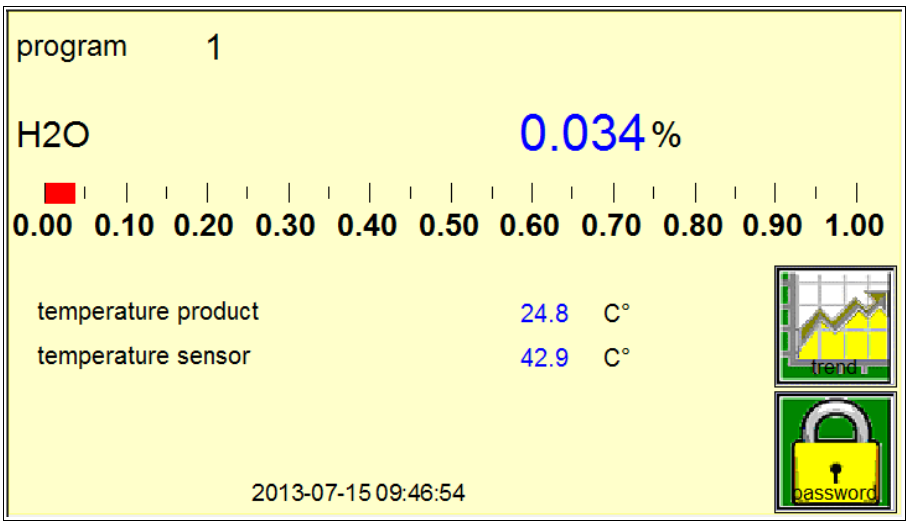
2.2 Standard Operation

During standard operation, the device has two modes:

Measurement and **Calibration**.

Measurement Mode

In **measurement** mode, the standard data display with the currently measured data is shown:

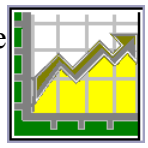


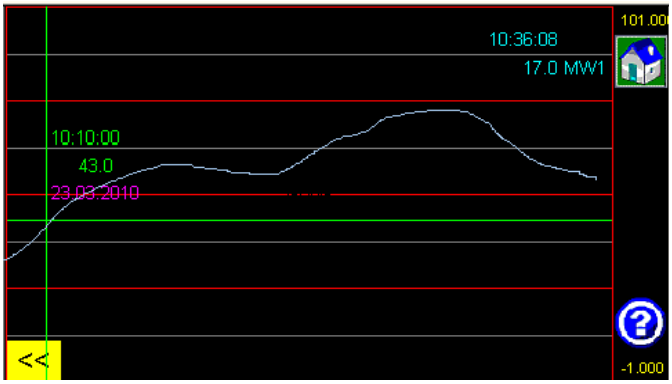
The standard data display shows the following information:

- The water content in percent as a numerical value;
- The water content on a bar graph between 0% and 1%;
- The temperature of the product in the flow cell;
- The temperature of the internal sensor;
- Date and time.

If active, this display can start a screen saver after a defined time. The screen saver can be configured or switched off (see Section 4.4, page 20).

The display can be changed to a time series by pressing the “time chart” button. The time chart indicates the recent development of the measured data. This helps to identify unusual events in the recent past.





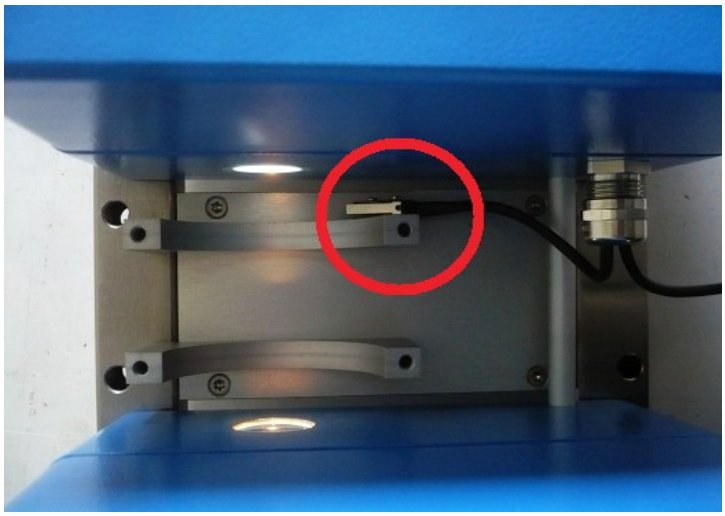
You can change the rate at which the time chart is updated by pressing the “?” button. A number keyboard appears and you can enter a new value (in seconds) or abort by hitting “ESC”.

Change the shown data range by touching the value indicated at the top or at the bottom of the y axis.

Leave the time chart by pressing the “Home”  button.

Calibration Mode

If the analyser is equipped with a mechanical switch as shown in the following image, then the **calibration** mode starts automatically when the flow cell is removed in order to insert the calibration samples. The only possible operation here is to perform the calibration as described in Chapter 3.



Analysers without this switch provide a “Calibration” button  to start the calibration mode manually.

Once the calibration is finished, remove the calibration samples and re-install the flow cell. Then the analyser will automatically switch back to the measurement mode.

Configuration

Other operations, such as editing basic settings, are available only after entering the password after pressing the lock symbol on the data display. Those operations are described in Chapter 4.

2.3 Maintenance

Once the system is running, little maintenance is required. For constant data quality, we recommend to follow these maintenance procedures at the specified time intervals:

- Check the **signal intensity** (Section 4.2, page 18) in regular intervals to make sure that the lamp output is stable and that the signal path is not obstructed by dirt. Under conditions of severe pollution, the optical path has to be cleaned regularly.
- **Calibration:** The photometer needs to be calibrated at regular intervals, at least **twice per year**. The calibration procedure is described in Chapter 3.
- **Restoring the calibration samples:** The calibration samples have a limited life time, as brake fluid is a hygroscopic substances and draws moisture from the air over the years. A reliable calibration is then no longer possible. Therefore the calibration samples have to be re-characterised or replaced **after the life time indicated** by the supplier of the samples. We will be glad to assist you.
- **Lamp replacement:** Any lamp ages and deteriorates in quality over time. The incandescent tungsten lamps have a life time of one year (of continuous operation) which is enhanced by the reduced operating voltage. To maintain a constant level of data quality and to avoid down time, we recommend to replace the lamps when their life time is reached. Replacement lamps can be obtained from us. The replacement procedure is described in Section 10.1, page 41.
- **Battery replacement:** A backup battery maintains system data when the device is without power. To our experience, this battery lasts for about two years until it needs to be replaced. It can be obtained from us or on the free market. The replacement is described on page 41.
- Replacement of mechanical and electronic components: All other components of the system are designed for a long life time and do not require maintenance in normal operation.

3 Calibration

3.1 Introduction

Photometry is based on the processing of relative signals. Therefore, a calibration is required in order to obtain scaled measurement data for each substance that is to be detected. This calibration is performed with two reference probes of known composition.

When shipped from the factory, the analyser has settings that fit best to the measurement sensor and excellently meet the application requirements.

We assume a linear measurement characteristic and perform a simple **two-point calibration.**

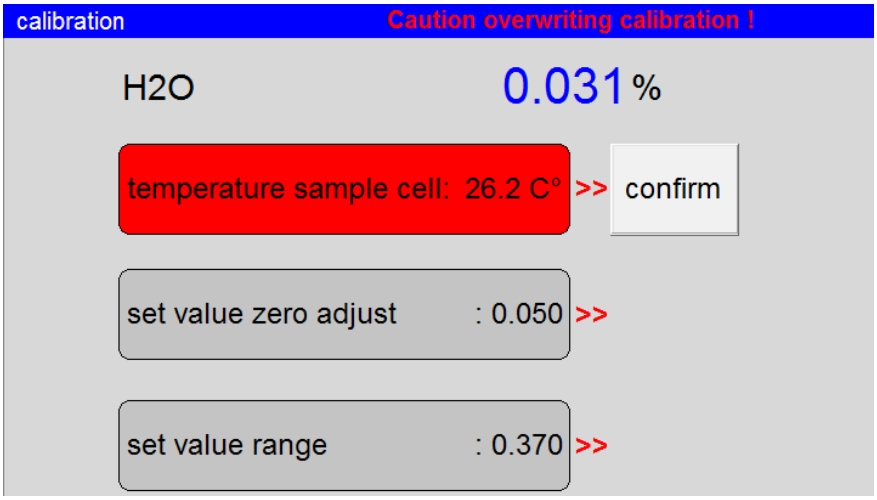
Important preparation:

- **The analyser must be switched on prior to calibration for no less than 1 hour at least.**
- **The required heat-up time is increased when components are integrated in housings without ventilation.**
  In flame-proof enclosures, the heat-up time can increase by several hours.
- **Take the calibration samples from their storage and place them near the actual measurement location (but not installed) at least 1 hour prior to calibration.**
- **Only install the calibration samples into the optical path when ready for the calibration. The samples should not remain in the optical path of the photometer for more than one minute. Otherwise they heat up and make the measurement invalid.**
- **Have a thermometer ready because you will need the temperature of the measurement location.**
- **Make sure that there are no unconfirmed error messages or warnings that would impede a correct calibration procedure. One example is the message "signal invalid".** (During calibration, error messages may appear for technical reasons, e.g., while a sample is replaced. As long as the measured data return to sensible values with a sample in the optical path, such messages do not affect the correct calibration procedure. They can be removed after completion of the calibration.)
- **Switch off automatic functions and external controls.**

3.2 Calibration Procedure

a) Remove the flow cell from the optical path. This will switch the screen from the data display to calibration mode automatically.

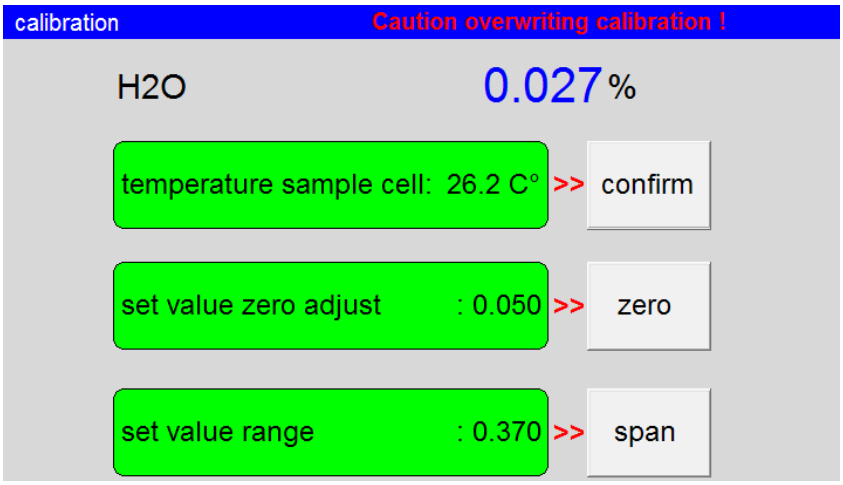
b) It is very important that the program knows the actual temperature of the calibration samples. Therefore, you cannot proceed before you have entered their temperature, and all buttons are grey and inactive. Follow the preparation step described on the previous page so the samples can adjust to the environment temperature.



Calibration window waiting for a confirmation of the temperature of the calibration samples (not the flow cell!)

Measure the environment temperature, e.g., with a normal thermometer. Press the red button "temperature sample cell" and enter the measured temperature. You can skip this step if the measured temperature is the same as indicated by the red button.

c) Press the "Confirm" button. The other buttons should turn green.



With the temperature confirmed, the calibration can be performed.

d) Take the calibration sample with the lower number. If you see bubbles in its window, shake or turn it to remove the bubbles. Then insert the sample into the optical path of the photometer.

e) Wait about 10-20 seconds until the displayed value has stabilized. Press the second button “set value zero adjust”. With the keyboard that appears, enter the value printed on the calibration sample that is currently inserted, and press OK to remove the keyboard.

f) Press the “zero” button to perform the calibration at the first point. The message “zero scaling active” appears. Wait until it disappears.

g) Take the calibration sample with the higher number. If you see bubbles in its window, shake or turn it to remove the bubbles. Then insert the sample into the optical path of the photometer.

h) Wait about 10-20 seconds until the displayed value has stabilized. Press the third button “set value range”. With the keyboard that appears, enter the value printed on the calibration sample that is currently inserted, and press OK to remove the keyboard.

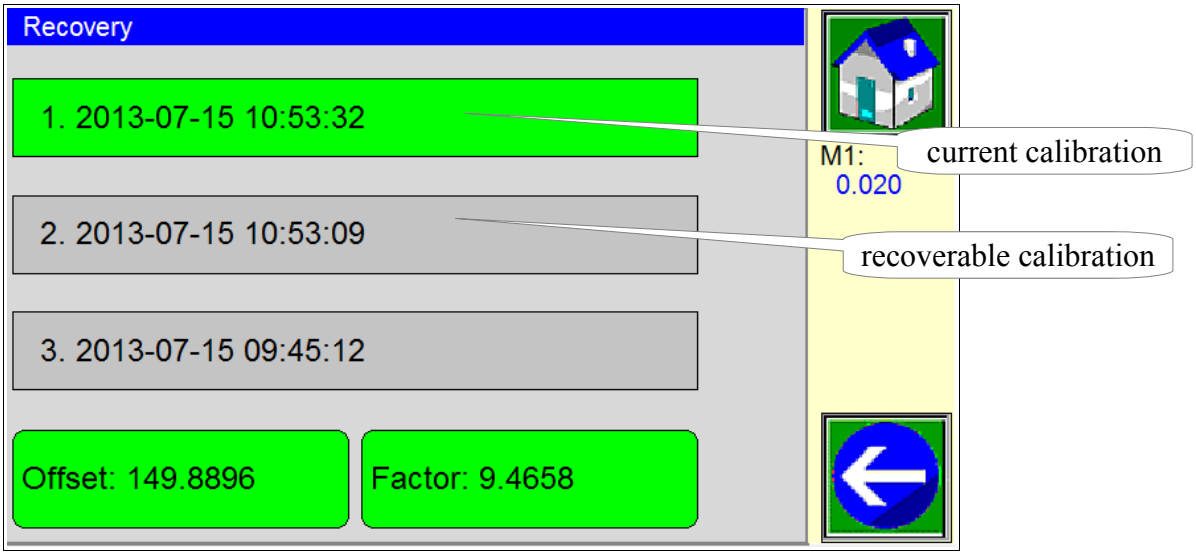
i) Press the “range” button to perform the calibration at the second point. The message “scaling active” appears. Wait until it disappears.

j) Remove the calibration sample from the optical path and re-install the flow cell. The analyser should return into measurement mode automatically and show the data display.

3.3 Calibration Recovery

The analyser keeps track of the last three calibration settings. Therefore, if something goes wrong during a calibration procedure, a previous calibration can be restored so the analyser can be operated with the old calibration until another, newer calibration is performed without errors.

In the password-protected menu, press the “Recovery” button. The following windows appears:



For each calibration in memory, the date and time are displayed. The active calibration is marked in green.

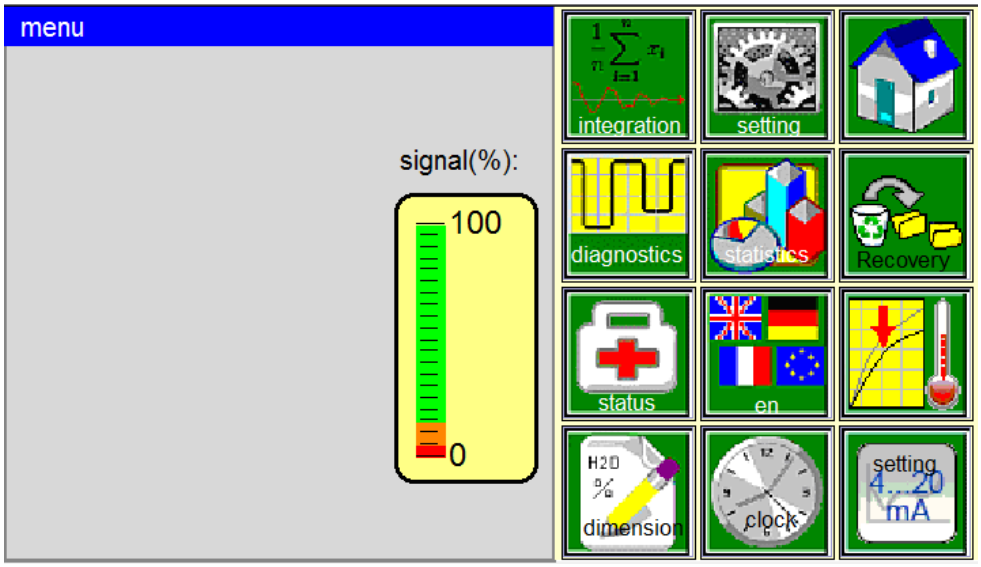
If needed, select one of the two older calibrations (typically, the most recent one that worked) to restore its settings to the analyser.

Alternatively, known offset and slope (factor) values from an older calibration can be entered manually by pressing the “Offset” and “Factor” buttons, respectively. The zero-adjustment and scaling sample values have to be entered in the “Calibration” window.

4 Extended Menu

4.1 Password Protection

The extended menu can only be reached by entering the correct password. In the data display, press the “Lock” button. A numerical keyboard appears where you can enter the password (factory setting: 1234). If the wrong password is entered, the screen returns to the data display. Otherwise, the following menu window is displayed:

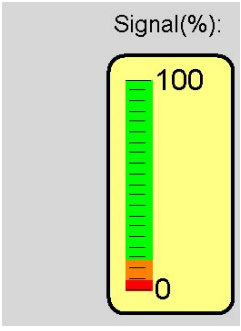


Its elements are explained in the following sections. From each menu, return to the advanced menu by pressing the “Back” button. Return to the main data display by pressing the “Home” button.

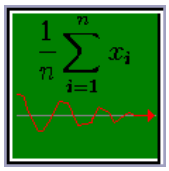
Back button

4.2 Signal level display

This displays shows the signal intensity of the light source in %. If the signal intensity is lower than 1% or higher than 101%, an error message is displayed. In that case, check the lamp of the light source.



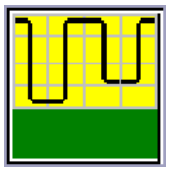
4.3 Settings buttons



Here, the integration time for the measurement and for the calibration (adjustments) can be entered in seconds. The integration time determines for how long the raw signal is accumulated to produce final data. Larger values smooth the signal, lower values provide higher temporal resolution and faster response.

Here, settings regarding the IP/network connection, screen saver, and data recording can be modified (see Section 4.4, page 20).

The “Home” button always brings you back to the main page (data display).



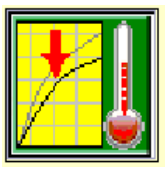
Diagnostic display for signal analysis (see Chapter 8, page 38).

Statistics. This window displays the minimum, the maximum, and the mean value of the measured data. Furthermore, the statistics can be reset (see Section 4.5, page 21).

The recovery menu keeps track of the three most recent calibrations. If something goes wrong during a calibration, a previous calibration can be recovered and loaded into the active program. See also Section 3.3on page 17.

The Status List displays current values that are relevant for the data processing (see Section 4.7, page 22).

This button provides a setting for the language of the menu and the display. Currently, English (**en**) and German (**de**) are available.



The temperature menu contains the settings for the temperature compensation. This process is explained in detail in Chapter 6, starting on page 27.

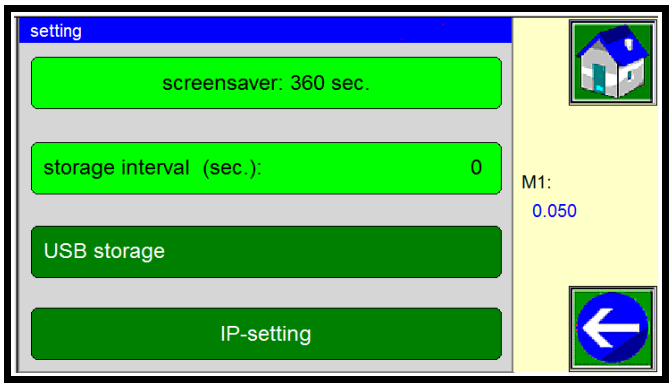
This button displays the Program Configuration. Names of measured quantities, their unit/dimension as well as the number of fractional digits can be set here (see Section 4.6, page 21).

The “Clock” button opens a menu to set date and time (see Section 4.8, page 23).

This menu contains the settings that control the analog output (see Section 4.9, page 23).

4.4 Settings for the screen saver, IP address, and system data

This menu contains the following window:



The **screen saver** can be activated and configured with the upper button screensaver. A number pad is displayed. The screen saver is deactivated by entering “9999”. All other values (in seconds) set the time after which the screen saver starts after lack of operator interaction. The smallest possible value is 60 s. Confirm your input with OK.

The button **IP-setting** can be used to configure the network connection to a computer (IP Adr., Net Mask and Gateway). The IP settings are explained in detail in Chapter 7.

The third field determines the location of the data files. There are two options, “USB storage” and and “internal memory”. If “USB storage” is selected, a USB flash drive has to be connected inside the right box of the analyser, otherwise a message data saving not successful is issued.

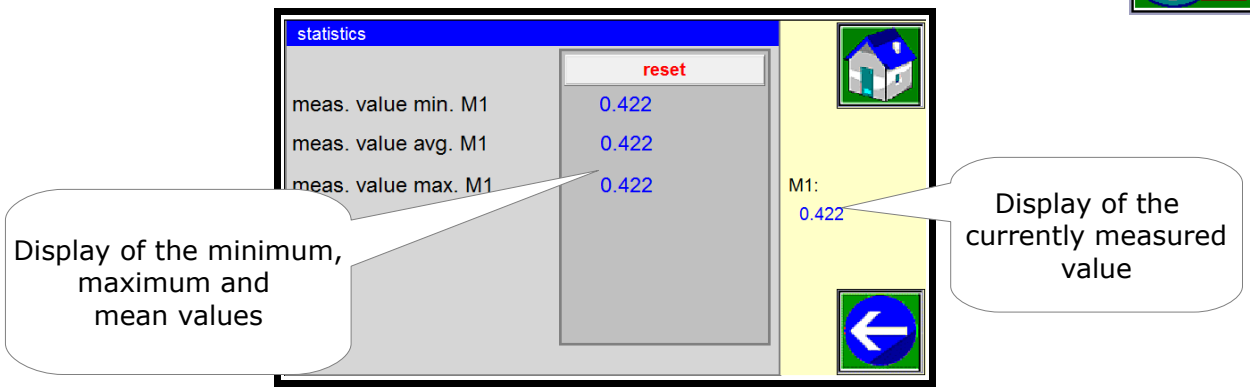
The second button storage interval (sec.) sets the time between save data points (in seconds). This value can range from 1 (1 value per second) to 3600 (1 value per hour). If this is set to “0”, data recording is deactivated.

If a value larger than 0 is selected, data recording starts. The third button is greyed out as long as data are recorded. It will become active again once data recording is stopped. Data are written into files named `pierlogX.csv`. The `X` is a sequential number.

If data recording is configured to save data into internal memory, the files can be found via FTP (see Section 7.3, page 32) in the directory `b/log`. If data are saved to a USB flash drive, they can be found in the root directory of that drive.

4.5 Data Statistics

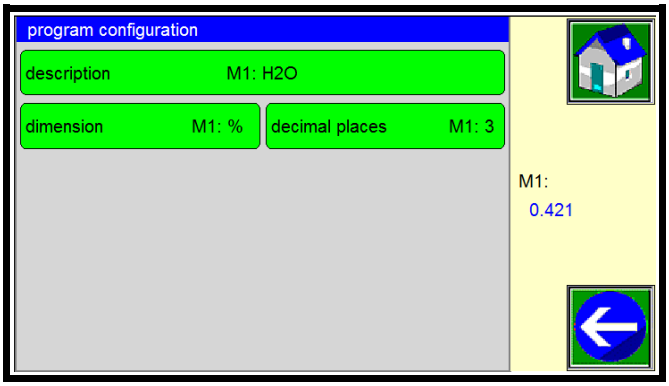
The statistics menu contains the following display:



Press the "reset" button to set all values to zero. The statistical sampling starts over.

4.6 Program Configuration

This menu contains settings for the label of the measured data (quantity), its unit (dimension), and the number of decimal places to be displayed:



Press one of the green buttons to change the corresponding value. A keyboard will appear where you can enter the new settings, confirm with OK. Return to the data display with the "Home" button or the advanced menu with the "Back" button.

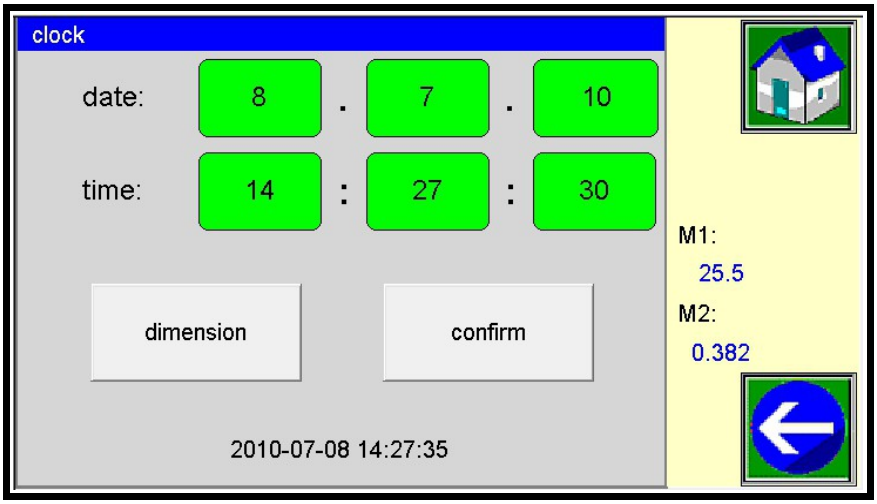
4.7 Status

The “Status” list contains all important intermediate values that are used for the measurement and the analysis. Modifications are not possible.

Menu line	*Description*
CPU DATA	
ch1 (bits):1	voltage at A/D converter K1
ch2 (bits):1	voltage at A/D converter K2
ch3 (bits):1	voltage at A/D converter K3
uncorr. meas. value1	measured value 1 before calculation steps and compensation
scaled meas. Value M1	measured value M1 after scaling
M1 after interpolation	measured value M1 after interpolation
scaled meas. Value M2	measured value M2 after scaling
M2 after interpolation	measured value M2 after interpolation
corr. value T1	value after temperature correction T1
corr. value T2	Correction value resulting from the difference in temperature T2 and reference temperature
corr. Value ext. Comp:	correction value resulting from the difference in measured value and reference value of the external compensation
SENSOR DATA	
analog in 00	analog input 0
analog in 01	analog input 1
analog in 02	analog input temperature input 1
analog in 03	analog input temperature input 2
analog in 04	analog input board temperature
digital in 00	digital input
digital in 01	digital input
Digital out 00	digital output 0
Digital out 01	digital output 1
ANALOG OUT DATA	
analog out 00 mA	current output 1
analog out 01 mA	current output 2
analog out 02 Volt	voltage output 1
analog out 03 Volt	voltage output 2
analog out 00	analog output 1
analog out 01	analog output 2

4.8 Real-time clock

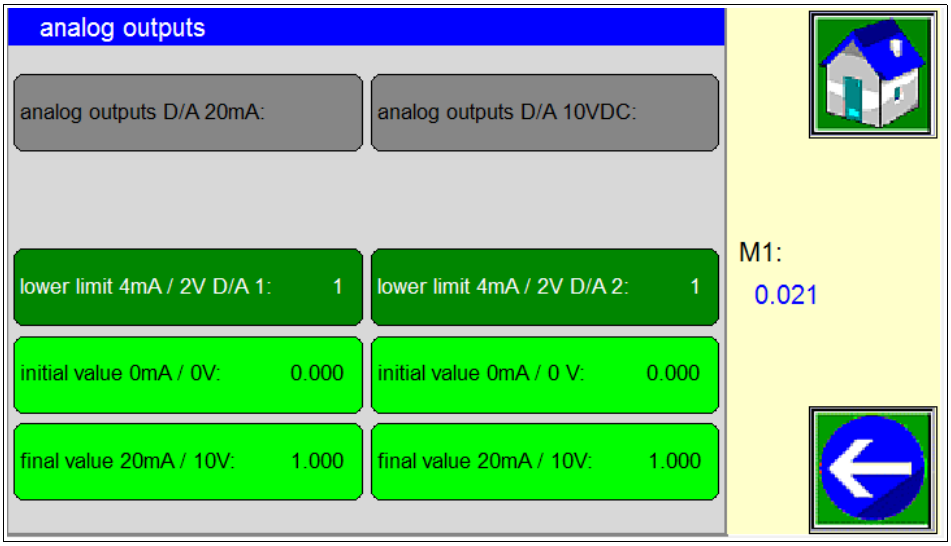
The analyser is equipped with a real-time clock. The time and date can be modified in this menu. The clock does not automatically adapt to summer / daylight saving time. The format of the time and date display can be changed with the 'dimension' button.



4.9 Analog output

This menu contains the following settings to manipulate the analog output:

The left column controls analog output 1. The right column for output 2 is unused.

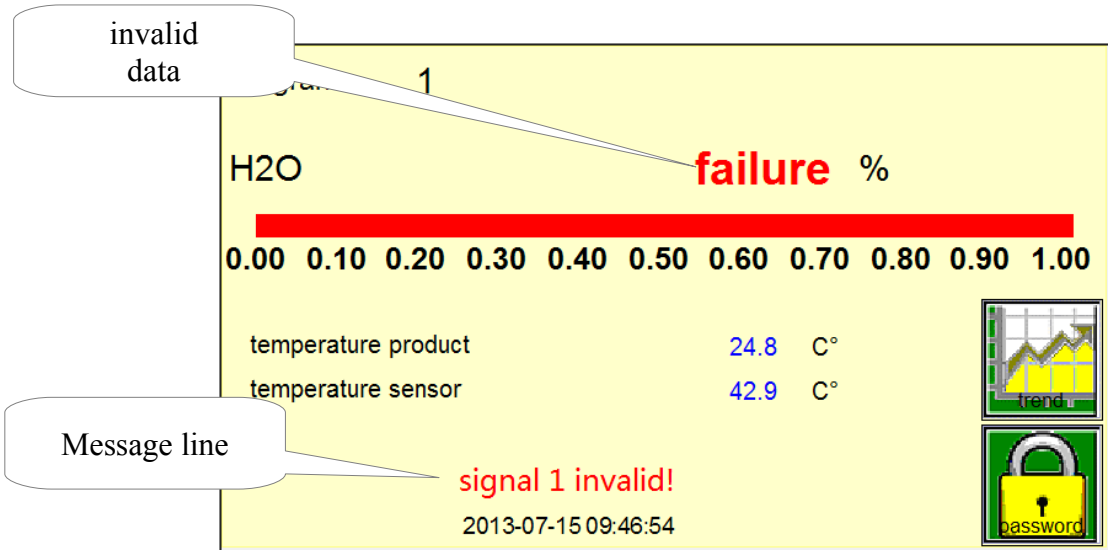


The lower limit can be set to 4 mA or 2 V by setting the corresponding toggle buttons to “1”, otherwise the lower limit is 0 mA or 0 V.

The “initial value” and “final value” buttons determine which data values the lower limit and the upper limit of the output range correspond to, respectively.

5 Error messages and warnings

If “Failure” is displayed instead of data, a critical error has occurred and the measurement is **invalid**. This message is deleted automatically as soon as the cause of the error is removed. It is possible that there is more than one cause.



The message line contains a unique error message describing the latest malfunction. The message in the message line can be removed by touching it. The message may appear repeatedly if the error was detected several times. When the error is gone, the message can be removed by pressing it several times. If the cause of the malfunction has not been removed, the error message prevails and the message line is updated accordingly.

An important tool for troubleshooting is the “Status” window**.**

The following applies:

It is not necessary to confirm (remove) messages, and unconfirmed messages do not lead to a permanent disruption of measurements. As soon as the cause of the error message has been removed, regular measurements start automatically.

If possible, the message line is also displayed in other menu windows so that the effect of setting changes can be seen immediately. The confirmation (removal) of a message is only possible in the data display window.

The confirmation of an error message or warning is acknowledged by a short grey background of the message line.

In the following, we distinguish between error messages, messages, and warnings.

5.1 Error messages and trouble-shooting

The following description of trouble-shooting assumes an originally correctly working configuration. During set-up or maintenance, irregular states are possible that do not require any or only temporary setting changes.

signal 1 invalid
signal 2 invalid

Error: One or more signals of the measurement sensor are outside their valid range. Regular measurements are not possible, as long as the cause for one of these error messages prevails.

Solution: The **entire** measurement system has to be examined for a malfunction.

meas. value invalid

Error: The data to be displayed is larger than 900,000 or smaller than -90,000.

Solution: The calibration needs to be verified.

5.2 Messages

Messages are related to functions and parameters that are optional in certain applications and will not impede the general function of measurements. Furthermore, messages may occur due to operator input.

However, they may be an error related to an application if messages are not automatically deleted from the message line.

measuring stop

The data display and output freeze due to an external reason.

Cause: A triggered measurement has been configured which makes it possible to freeze or lock the data processing by external control signals.

Solution: Remove the cause for the (erroneous?) external control signal. Beware that there may be an immediate change in the data signal when data processing is resumed.

signal luminosity too big

This message indicates that the detected transmission is larger than 101%. If the transmission exceeds 110%, the measured data value is replaced by a “failure” warning.

signal luminosity too small

This message indicates that the detected transmission is smaller than 1%. If the transmission falls below 1%, the measured data value is replaced by a “failure” warning.

5.3 Warnings

Warnings are related to operational procedures or certain input buttons. Therefore, they may occur at different locations in the menu and cannot be confirmed.

zero setting, please wait

During a calibration, the zero setting is currently being performed. Its duration is determined by the integration time. This warning disappears after the end of the zero-setting process.

scaling active, please wait

During a calibration, the scaling is currently being performed. Its duration is determined by the integration time. This warning disappears after the end of the scaling process.

Version XX

After start-up or after a power outage, the version number is indicated for approx. 20 seconds.

6 Temperature Compensation

The analyser has two compensation channels (Pt 100) for **temperature compensation.** Two temperatures can have an influence on the measured data: The temperature of the sample (inside the flow cell) and the internal temperature of the measurement sensor (inside the right blue box).

The factory setting for the temperature compensation is usually based on the specifications of the facility operator. If no such specifications were known, standard environmental conditions are assumed. When the settings are changed, adequate changes of temperatures have to be ensured during the adjustments.

Unless agreed upon otherwise, the following definitions hold:

T1: Compensation with respect to the product temperature.
The temperature sensor is mounted directly into the flow cell.

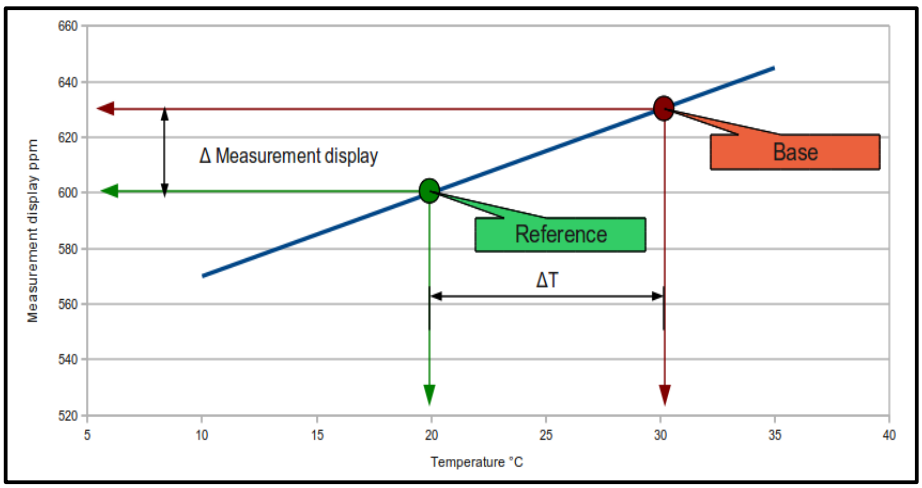
T2: Compensation with respect to the sensor temperature.
The temperature sensor is mounted into the optical sensor.

The temperature compensation works best if the calibration of the system (Chapter 3) is done at the nominal (usually expected) temperature of the product and the sensor. Ideally, that temperature lies in the middle of the expected range of minimum and maximum temperature. As the calibration provides the reference points for the temperature compensation, the extrapolation errors are then the smallest.

If known, the temperature dependence can be entered directly into the analyser. This is done with the button Correction value / °C in the “Temperature Compensation” menu. During the measurement, the correction value is calculated based on the difference between the current temperature and the sample temperature during the most recent calibration.

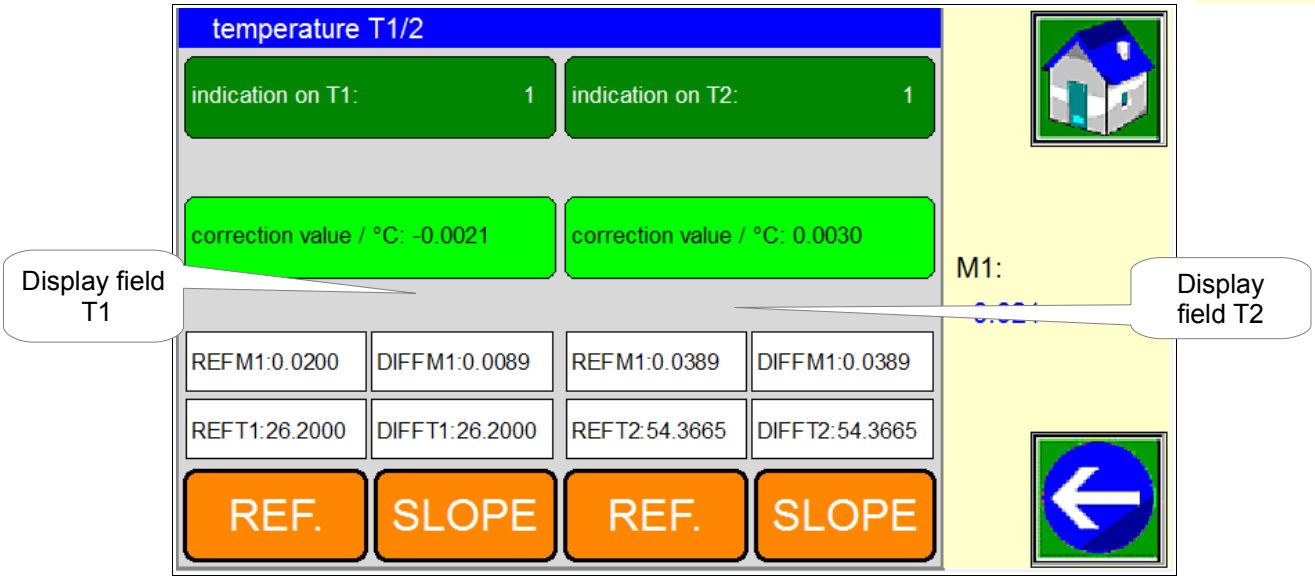
Otherwise, the temperature dependence can be determined experimentally (see next page). For this, the temperature of the sample has to be changed throughout the expected temperature range. The graph below shows an example for a linear temperature dependence of the data.

It is recommended to first check the influence of the sensor temperature and compensate for it, if required. Stabilize the product temperature and vary the sensor temperature in the expected and safe range.



Two points are required for a correct (linear) compensation: first, the measured data value at the nominal temperature (reference point); second, the measured data value at a second temperature (Scaling point). The analyser uses these two values to determine the slope of the line (correction value per degree Celsius).

Enter the advanced menu (see Chapter 4) and push the “Temperature Compensation” button. The following window appears:



Note that the “REF” and “SLOPE” buttons only appear during a later point of the adjustment (see below).

If the temperature characteristic is known, press the “Correction value” button to enter the correction factor (per degree C) directly.

indication on T1: If set to “1”, the temperature used for compensation is indicated on the data display. Entering a “0” deactivates that indication as well as the following fields.

Setting the compensation

a) First set the reference point. Bring the sample to the nominal temperature. Press one of the white fields underneath T1 for at least five seconds. Then two additional buttons appear: REF. and SLOPE.

In order to enter the current data value and the reference temperature, press the REF. Button. The reference values appear in the corresponding fields.

b) Now raise the temperature of the sample by 10 °C. The indicated data should vary according to the physical temperature dependence of the measurement.

c) This scaling point is entered by pressing the SLOPE button.

The same procedure is followed for T2. In this case, the temperature of the measurement sensor has to be regulated instead of the sensor temperature.

7 Data Interfaces

The analyser has several interfaces to establish a connection with a computer or other processing systems. Typical applications include:

- Real-time data monitoring;
- Extraction of measured data for further processing;
- Creation of backup copies of the measurement programs.

7.1 Network connection (Ethernet)

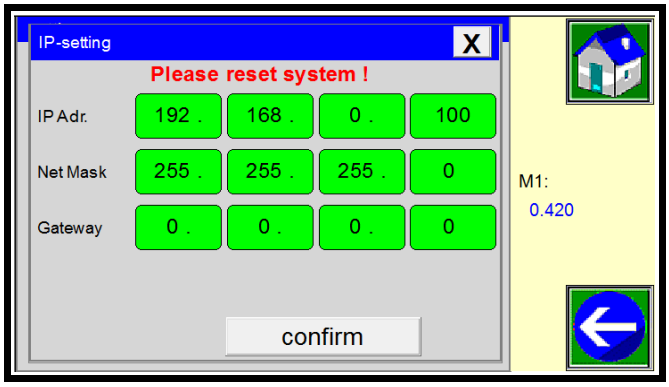
The MV-230T can be directly connected to a computer using a crossover Ethernet cable if the computer has a LAN interface. The network speed is 10 Mbit per second. The Ethernet jack is inside the receiver housing, on the rear side of the touch screen.

The analyser comes with factory settings for a working network connection. If the analyser is not only connected to a single computer but to a larger network, these settings may need to be modified.

The IP address of the computer has to agree with that of the MV-230T at those of the four parts where the net mask of the MV-230T is set to 255. You can either adjust the computer's IP address or that of the analyser.

On the computer, deactivate “Obtain IP address automatically” for the Ethernet network; a wireless connection is not affected. Then set an IP address that matches the above criteria.

The IP address of the MV-230T can be found and modified in the 'Settings' menu (see Section 4.4, page 20) in the following window:



Touch each field to change the corresponding value. The buttons have the following meaning:

Line	*Parameter*	*Factory setting*
IP Adr.	IP address	192.168.0.100
Net Mask	Net mask	255.255.255.0
Gateway	IP address of the network gateway	0.0.0.0 (= no access to other networks)

Press the “X” in the upper right corner to return to the main menu. The network parameters can be set partially by pressing the button for each part (usually, not all parts need to be changed).

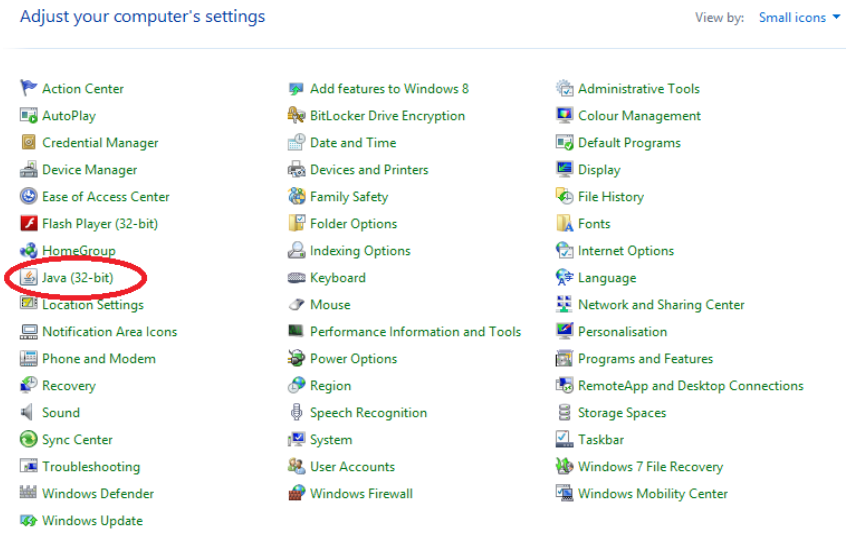
7.2 Web Visualization (Web browser)

Once connected (see above), the web visualization can be reached in a web browser under the following address:

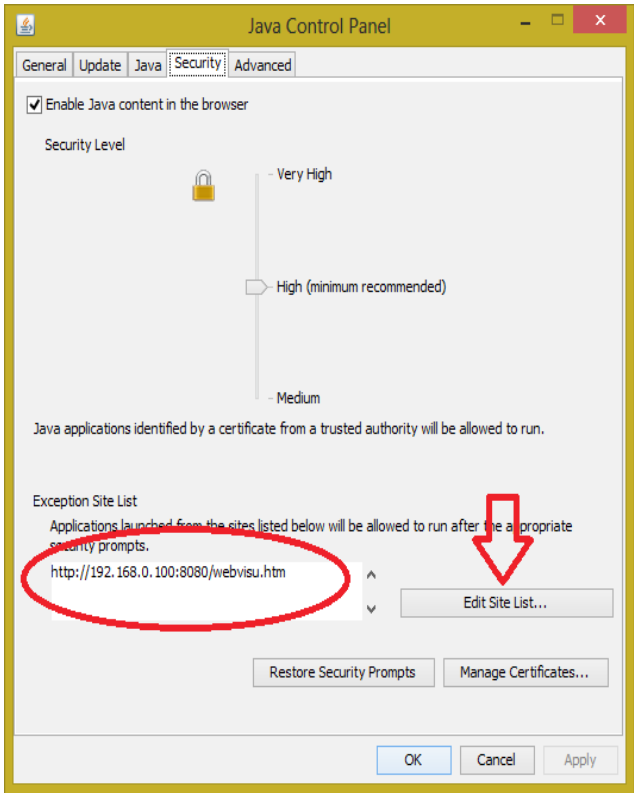
http://192.168.0.100:8080/webvisu.htm

If the IP address of the analyser has been changed, the address needs to be adjusted accordingly.

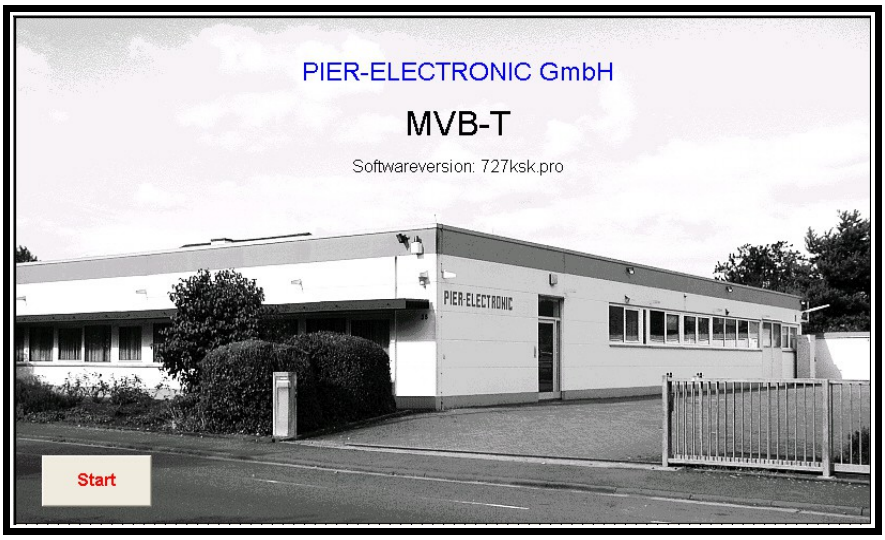
Starting with the JAVA update 7.51 of January 2014, JAVA applications are blocked unless explicitly permitted in the security settings. This does affect this web visualization. To unblock it, open the computer's control panel and enter the JAVA menu:



Add the address of the web visualization (see above) in the exception site list:



After the connection has been established, this start-up image is displayed in your browser:



Upon clicking the “Start” button, the data display of the analyser is displayed on the computer. It can be changed to the bar diagram. Also the menus “Statistics” and “Status” can be shown. Control menus are not available for security reasons.

7.3 FTP Access

The FTP connection can be used to transfer files with measured data from the analyser to a computer for further processing.

FTP access requires an Ethernet connection (see above). Once connected, you can use a web browser (e.g., Firefox) or an FTP client (e.g., FileZilla) to access the files and directories on the TMK480-CT. In a web browser, enter the IP address of the anaylser with the prefix **ftp://** , so for example: ftp://192.168.0.100

Note that the Microsoft programs “Windows Explorer” and “Internet Explorer” are **not suitable** to transfer files **from the analyser to the computer**. While functional in principle, they use a cache intended for faster internet transmissions. In our case, this has the effect that an old file from the cache is written to the destination instead of the latest version from the analyser, even when the user has performed all steps of the copying process correctly. As there seems to be no reliable way to deactivate the caching, we recommend to use a different program. (Possible but cumbersome methods include rebooting the computer and emptying the “Temporary Internet Files” for each access.)

The “Windows Explorer” is suitable to transfer files **from the computer to the analyser** just as any genuine FTP program.

Folder Structure

In the FTP program, you can see the following MV-230T directories:

```
a
b
bin
etc
media
```


The directory `b` contains, among others, these sub-directories:

```
log
prog
```

The directory `log` contains csv log files with measured data from the recording function (see the next section). These files can be copied to the computer for detailed data anlysis.

The directory `prog` contains binary ppg files (compiled program files). The ppg files can be copied to the computer to keep a backup copy. Later, the backup can be copied back to the analyser when needed.

The file of the program that is currently running on the analyser cannot be overwritten or manipulated. If you need to do so, you have to select a different program on the analyser first.

7.4 Data recording

Data can be recorded for further processing, diagnosis, and archiving purposes. The data can be recorded in internal memory or on an external USB flash drive (a USB port is inside the receiver housing on the back of the touch-screen unit). Data are written according to the FIFO principle (First-in-First-Out); new data overwrite older data. The data format follows this example:

```
02.07.2013 11:10:55;2;  42.56;38.6;OK
```

The parameters in each data set are separated by semicolons (;).

Meaning of the different parameters:

`02.07.2013 11:10:55`
: Date and time (format as displayed on the analyser; the format can be changed by the user, see Section 3.4)

`2`
: Number of the current measurement program

`42.56`
: Measured data M1

`38.6`
: Temperature T1

`OK`
: Status

The status is “OK” if measurements are running smoothly. Otherwise, it is one of the following:

Code	*Messages*	*Code*	*Messages*
1	zero meas. range overflow!	20	waiting for scale probe
2	zero meas. range underflow!	21	version 707.1ksk
3	scaling meas. range overflow!	22	test mode
4	scaling meas. range underflow!	23	measuring stop

5	signal 1 invalid	24	purging
6	signal 2 invalid	25	auto program sequencing active
7	signal 3 invalid	26	integration time overflow
8	program not existent	27	measuring output stop
9	scaling active, please wait	28	threshold M2 underflow
10	zero setting, please wait	29	threshold M2 overflow
11	threshold M1 underflow	30	dummy
12	threshold M1 overflow	31	signal 4 invalid
13	signal luminosity too small	32	data saving not successful
14	signal luminosity too big	33	no data from sensor
15	signal luminosity alert	34	Sensor signal overflow
16	filter active	35	Sensor signal underflow
17	measuring value invalid	36	Data recording not successful
18	automatic calibration active	37	no message, failure-free OK
19	waiting for zero probe		

Data recording is started, stopped, and controlled manually. This operation is described in Section 4.4 on page 20.

7.5 Data Processing on a Computer

Measured data are saved in ASCII files with the extension csv.

For quicklooks, they can be opened in a text editor. In Windows, right-click the file name and select “Open with...” → “Wordpad”. (The Windows “Editor” is not suitable!)

For further processing and plotting, the files can be imported into advanced software such as Microsoft Excel, OpenOffice Calc or Origin.

Microsoft Excel: Select “Open file”. Select file type “All files”. Select the data file and open it.

The text conversion assistant opens. Select the correct separator (usually “semicolon”). In the following window, select each column after another and set their data format to “Text”. Finally, the data are imported with “Finish”.

OpenOffice Calc: Depending on the regional/language settings of your computer, the columns may have to be set to “US English” format in the text import dialogue to make sure that decimal points and minus symbols are interpreted correctly.

7.6 Data monitoring via Modbus

Once connected via Ethernet, the measured data can be monitored on the computer in real-time via the Modbus-TCP protocol (with a software such as “Modbus Master” or “CAS Modbus Scanner”). The software has to be set to the IP address of the analyser, with Port 502, start address 1, total values 8, data type “4:Holding Registers”. The first three values displayed by the software correspond to the measured value M1 and the temperatures T1 and T2, as they are displayed on the analyser. Note that the measured data is multiplied by 10 or 100 in order to make the value integer; e.g., a data value of 0.032% is displayed as “32”.

7.7 Data Monitoring with RS485

If part of the order, the analyser has an interface for a two-line (half-duplex) RS485 connection. The connector pins are part of the CAN bus connector located inside the receiver housing on the rear of the touch-screen display. Line “A” is connected to pin 5 of the CAN bus connector, line “B” to pin 6. Adapters to a serial cable or USB are available from some electronics suppliers. If a computer without a serial port is connected, a serial-USB adapter will provide a virtual COMx port that can be chosen just like a regular COMx port.

To display the measured data on the computer, a terminal program can be used. Older versions of Windows provide the “Hyperterminal” for this purpose. In modern Windows systems, a tool such as “PuTTY” can be installed. Direct the terminal program to the correct COM port (9600 baud). The the terminal displays one line per second which contains the measured data value and a status code (“OK” or one of the status codes listed in Section 7.4, page 33). When the photometer is calibrated, the terminal displays the message “new calibration” and the new calibration parameters once.

7.8 Using the PROFIBUS Connection

If you have ordered the analyser with the PROFIBUS extension, the necessary hardware and software settings are included in the shipment to facilitate communication between the analyser and your PROFIBUS process control system.

By default, the PROFIBUS port transmits and receives sets of four 'words' (0–3; each 16 bit unsigned). The size of the sets can be increased to eight (0–7) to transmit more variables. The size of the set can be changed only by a service engineer of PIER-ELECTRONIC.

The following table illustrates the values transmitted in each data set:

Word	Variable	Remarks
0	Measured value M1	Scaled to integer
1	Product temperature	Scaled to integer (multiplied by 10)
2	Sensor temperature	Scaled to integer (multiplied by 10)
3	Measured value M2	Scaled to integer
4	*Value of additional compensation*	*Scaled to integer*
5	*Program number*	*Integer; can be changed externally*
6	*Error code*	*Integer*
7	*Signal intensity in %*	*Integer*

The data typed in *italics* are only transmitted with the increased size of the data set. The error code in word 6 corresponds to the table on page 33.

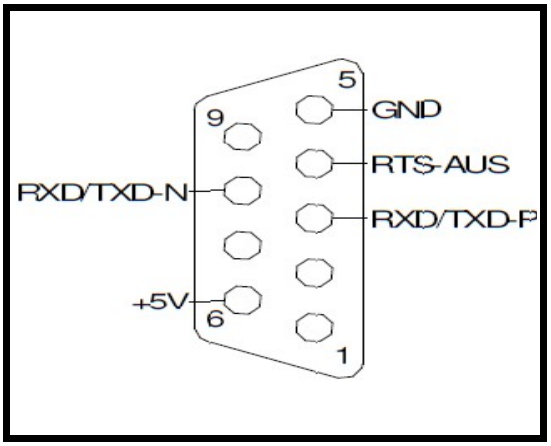
Technical Background for the PROFIBUS DP V0

PROFIBUS (Process Field Bus) is a standard for field-bus communication in automation technology. The PROFIBUS protocol provides a cyclical data exchange.

The PROFIBUS in this analyser is a PROFIBUS DP Slave. PROFIBUS-DP (Decentralised Periphery) to control sensors by central controlling in production technology.

Upon request, the PROFIBUS is wired by PIER-ELECTRONIC GmbH with a 9-pin Sub-D plug (An.67-2490).

1	Unused	6	+5 VDC
2	Unused	7	Unused
3	RxD/TxD-P	8	RxD/TxD-N
4	RTS output	9	Unused
5	GND		



Baud rate: up to 12 MBaud. The baud rate used by the PROFIBUS Master is detected automatically.

Setting of the PROFIBUS Slave address:

The address must range from 1 to 125 and agree with the configuration of the PROFIBUS Master. The PROFIBUS slave address can be checked and adjusted in the analyser's IP menu (see Section 4.4, page 20).

Error messages of the PROFIBUS hardware (located at the rear side of the touch screen of the analyser):

Red LED	blinks	Invalid CAN address
Yellow LED	blinks	Interface waits for initialisation
Green LED	blinks slowly	Interface ready but not started
	blinks fast	Interface ready but lost contact or stopped
	Continuous light	Interface ready and running.

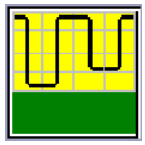
Possible values for PROFIBUS status:

0	Reset	LED 1 red
1	Device Init	LED 1 red
2	DP Wait Prm	
3	DP Wait Cfg	
4	DP Data Exch	LED 0 green
5	DP Error	
130	Test mode DP Wait PRM	
131	Test mode DP Wait Cfg	
132	Test mode DP Data Exch	LED 0 green
133	Test mode DP Error	

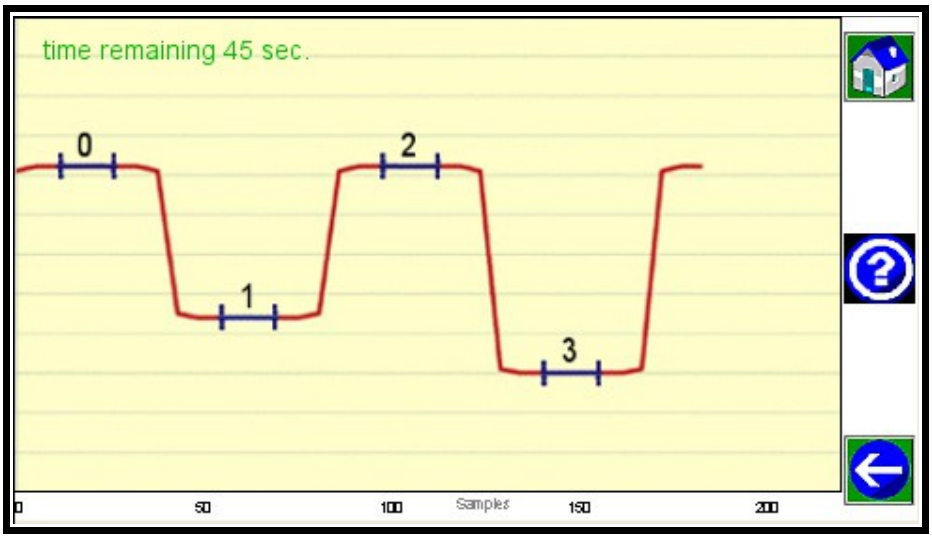
Possible values of PROFIBUS Error:

0	No error
1	Slave address invalid
2	Internal error
3	Internal error
4	Internal error
5	Internal hardware error
6	Internal hardware error
7	DP Error

8 Diagnostics

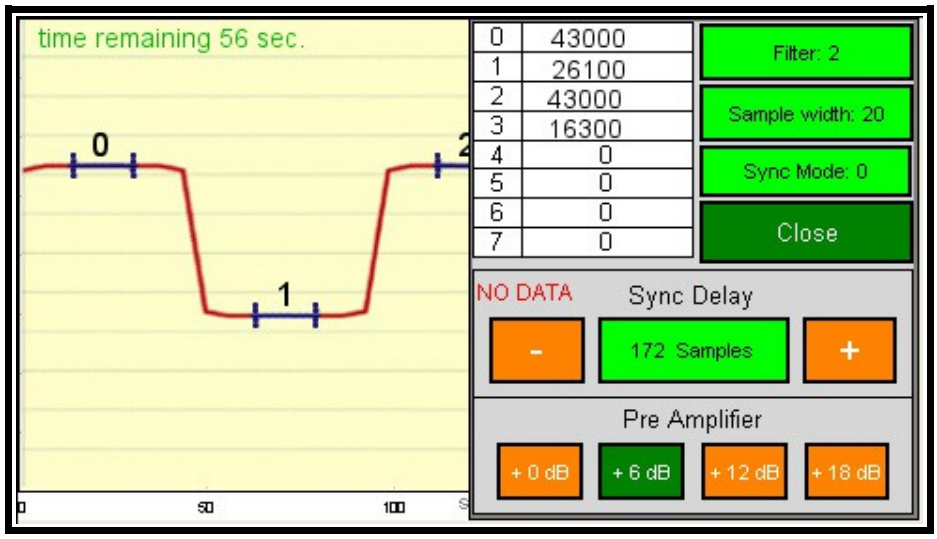


The diagnostics function provides simple monitoring of the functionality of the instrumentation. The raw signals of the separate filters can be analysed.
Settings can be changed only after the administrator password has been entered (see Chapter 9).



The “Diagnostics” mode is not a measurement. It quits and returns to regular operation after one minute, if no user input occurs. The remaining time is indicated in the top left corner of the screen. In order to re-set the countdown, touch the screen at any location.

By pressing the “?” button, more information is included:



The oscillogram shows the measurement signal (1) and the reference signal (3), with the base line (0 and 2) on top and the actual signals stretching down.

The blue bars on top and bottom of the signal indicate the sampling area. The width of these bars correspond to the “Sample width” parameter. Within the sampling range, data are forwarded to signal processing. Data outside the sampling range are ignored.

The sampling bars have another important function: They indicate the phase shift between the sampling and the filter-wheel motor. If the sampling bars are located in the centre of the level parts of the signal as in the figure shown here, then the phase shift is set correctly. Otherwise the phase shift can be adjusted with the “SYNC DELAY” button (in admin mode).

The width of the sampling bars is set (in admin mode) with the “sample width” button. The bars must cover a part of a horizontal line as wide as possible without coming close to the steep vertical edges.

The measurement signal is always at the first position. Its amplitude decreases when the concentration of the target component increases. When two wavelengths are used, the “SYNC DELAY” should be set to approx. 175 samples; with three wavelengths to approx. 15 samples.

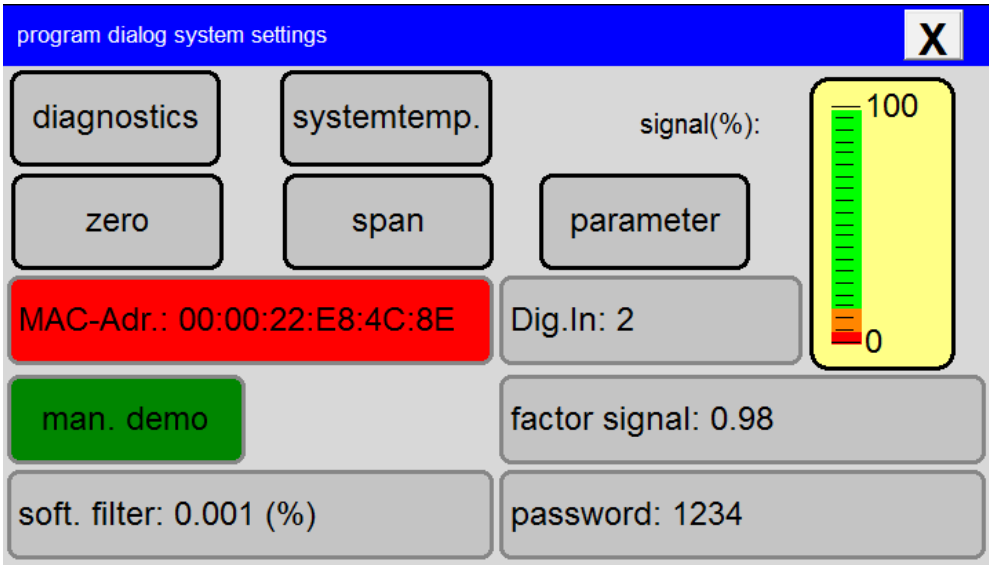
The analyser contains a pre-amplifier that can be set to amplifications of +0dB, +6dB, +12dB, or +18dB. This increases or decreases all signals equally. Be careful to avoid saturation under all possible conditions of operation. Saturation is indicated by a red warning CLIPPED next to the word PREAMPLIFIER.

The button “Sync Mode” has two settings: “0” means that the synchronisation is based on the mains frequency. “1” means that synchronisation is controlled by a magnetic rotation sensor. The “Filter” button specifies the number of filters (wavelengths).

9 Admin menu

Fundamental settings of the analyser can be changed only from a hidden menu. **Do not change these settings unless you have been instructed to do so by PIER-ELECTRONIC!**

To access the menu, first enter the extended menu (see Chapter 4). Press the left empty area for several seconds. Then a keyboard appears where the admin password 61222054 has to be entered. Then the following menu appears:



The “diagnostics” button links to the signal analysis menu described in Chapter 8, but with full control. The remaining buttons in the top two rows are related to the calibration of the analyser. The MAC address is required for correct network operation and is a factory setting.

The “Dig.In” button regulates whether the program allows direct access to the “Calibration” menu (setting “0”) or whether access is controlled mechanically by a switch that detects removal of the flow cell (settings “1” and “2” for positive or negative response).

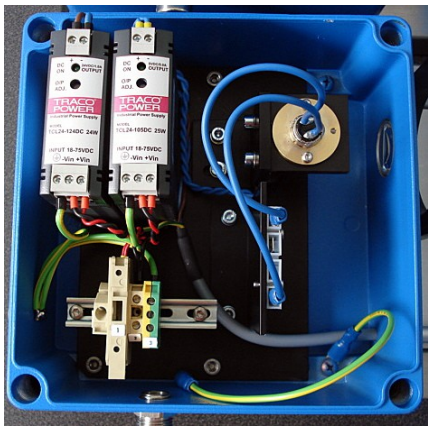
The “Password” button sets the password required to access the menu described in Chapter 4.1 from the main screen. The remaining buttons are for internal parameters. These values should only be changed upon instruction by PIER-ELECTRONIC.

10 Maintenance

Attention:

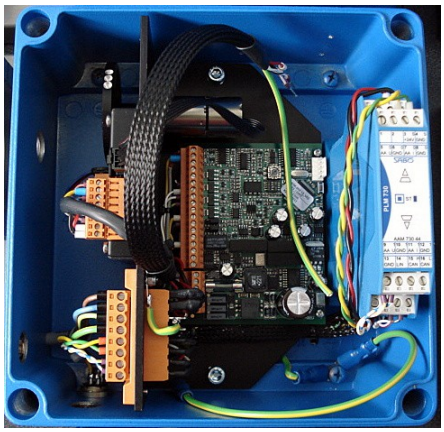
Please remove the analyzer from the power supply before starting any maintenance.

All important data have to be saved before starting maintenance.



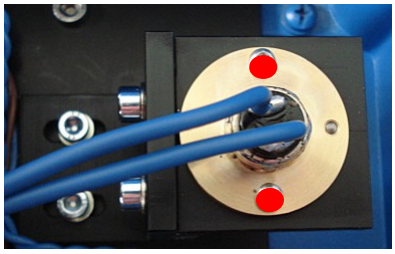
lamp housing

flow cell



receiver housing

10.1 Replacing the lamp



After opening of the lamp housing (beware of the grounding wire!), you can see the tungsten lamp and its socket. This socket is mounted with two screws (marked red) at the lamp bracket. Please use a Torx T8 screwdriver to loosen the screws.

Please open only these screws! Otherwise, the alignment of the optical path can be displaced.

Unplug the blue power wires from the connection panel. Remove the old lamp. Put the new lamp in its place with the third hole (on the right side in the image) fits the small bolt. Tighten the screws. Then plug the blue wires of the new lamp to the connection panel. Carefully close the lamp housing before restoring the power supply.

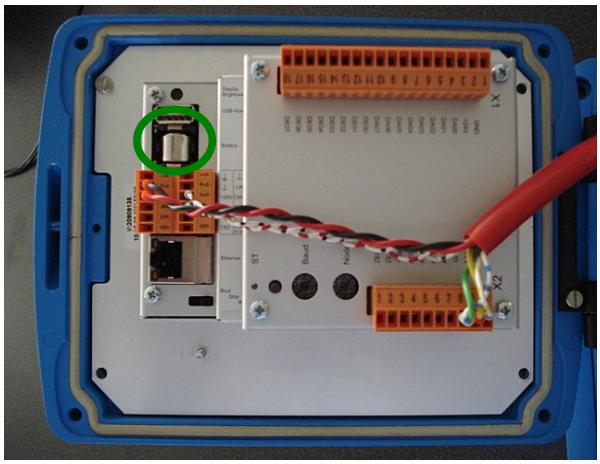
10.2 Replacing the battery

To change the internal battery (DL1/3N), first disconnect the power supply. All important data should be saved externally before changing the battery.

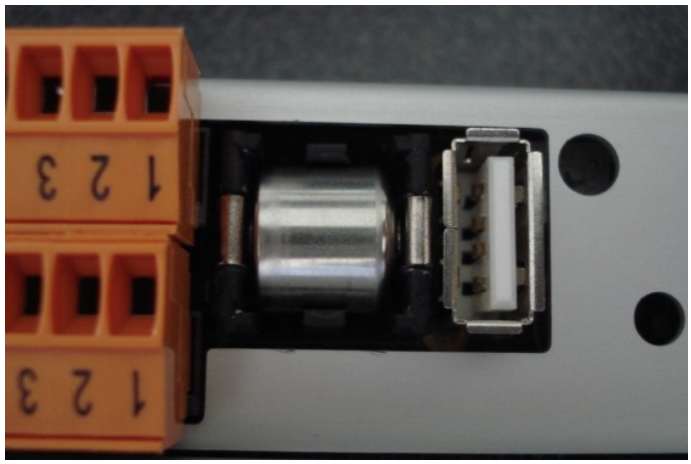
Open the four screws of the receiver housing. Carefully remove the front panel – attention to the grounding wire!

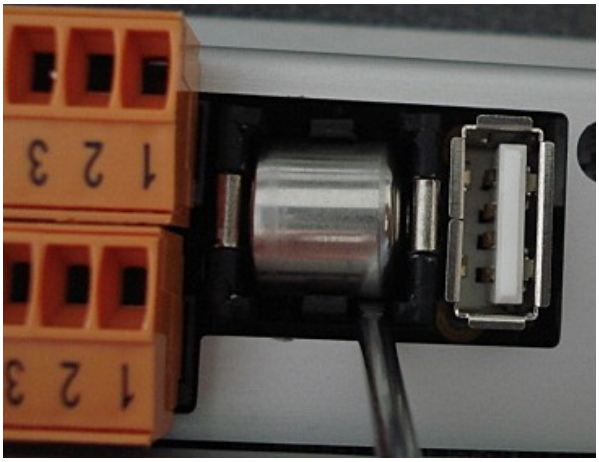
Now you can open the housing.

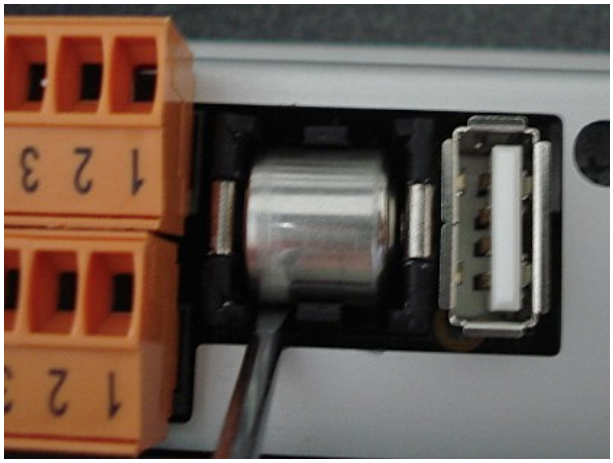
Now you can see the backside of the display.
The battery is located inside the green circle.
The type of the battery is DL1/3N.



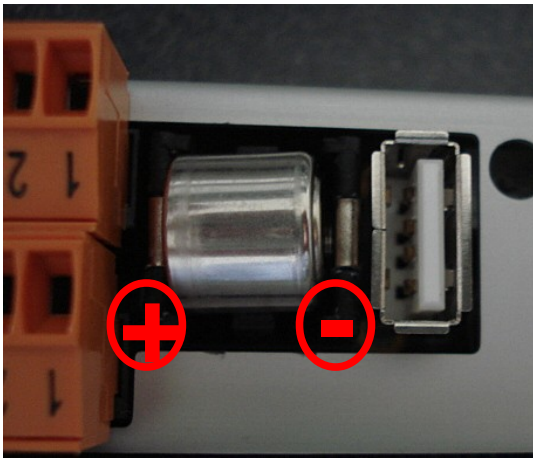
When inserting the battery, make sure to use the correct polarity!

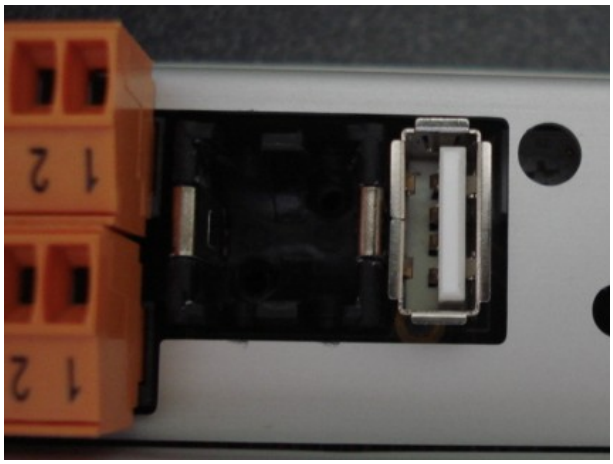






Carefully remove the battery with a screwdriver.

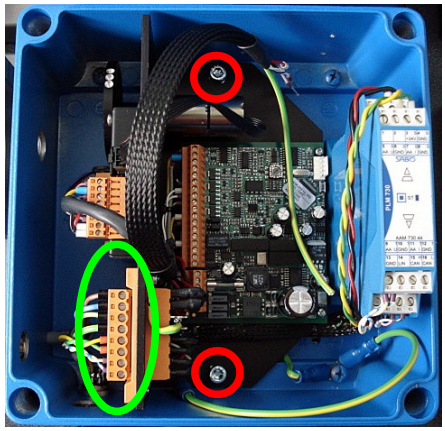




When inserting the battery, pay attention to the polarity!!

Advice: It is reasonable to note the date of the change of the battery.

10.3 Replacing the motor

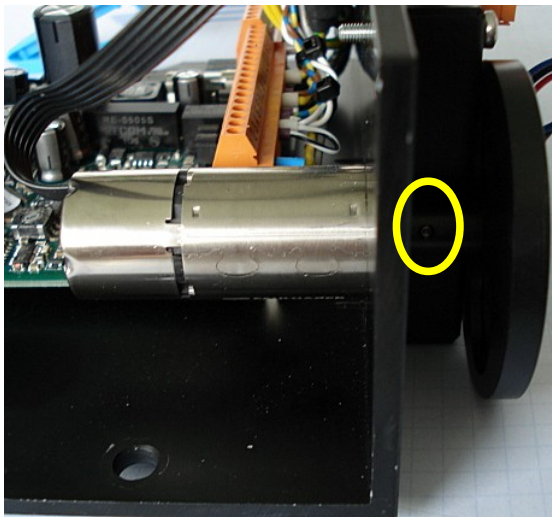


For a replacement of the motor, the receiver housing has to opened. After opening of the cover you can see the following:

To remove the chassis with the motor, the screws that are marked red have to be loosened and the connector marked green has to be unplugged.

To change the motor, the filter wheel has to be removed first.

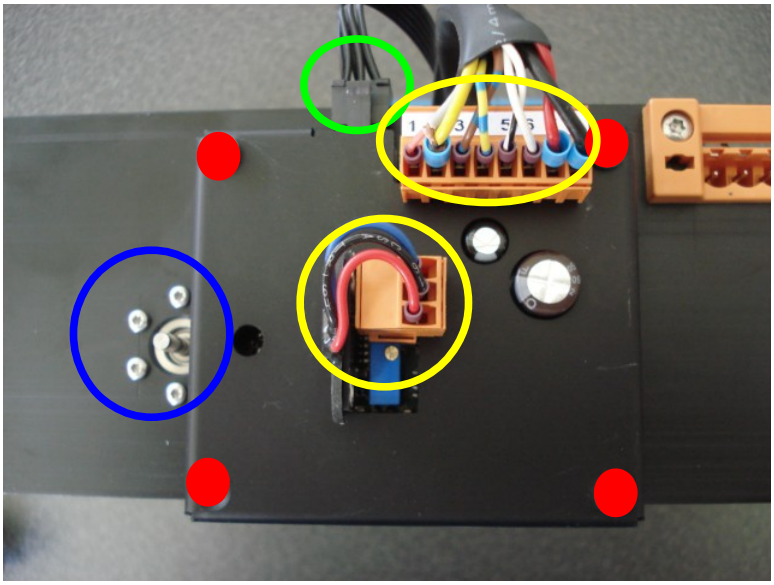
For this, the screw (marked yellow) has to be loosened and the filter wheel has to be removed from the motor axis.



Now remove the two orange plugs (marked yellow).

The motor is connected to the electronic with a plug. To remove this plug (green), the screws (red dots) have to be removed to release the cover plate.

Now the plug (green) can be removed. For this please push on the rocker switch.



Now the 4 screws M2x5 (blue) can be removed by using a Torx (T5) screwdriver.

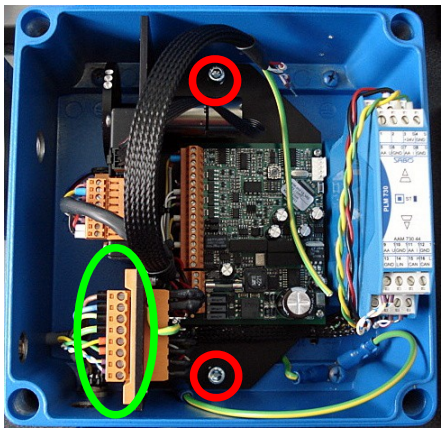
Now you can remove the motor from the chassis. To mount the new motor, follow the disassembly procedure backwards.

10.4 Replacing the pre-amplifier board with detector

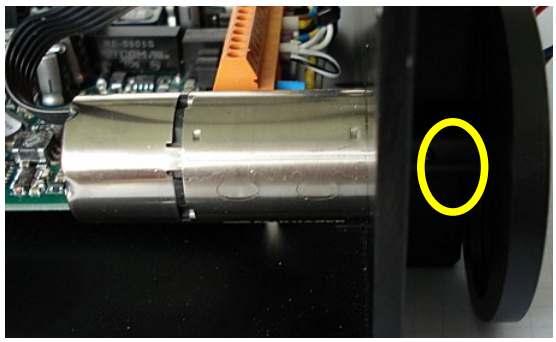
In order to replace the pre-amplifier board, the receiver housing has to be opened.

After opening of the cover, you can see the following:

To remove the chassis with the motor, the two screws marked red have to be loosened and the connector marked green has to be unplugged.

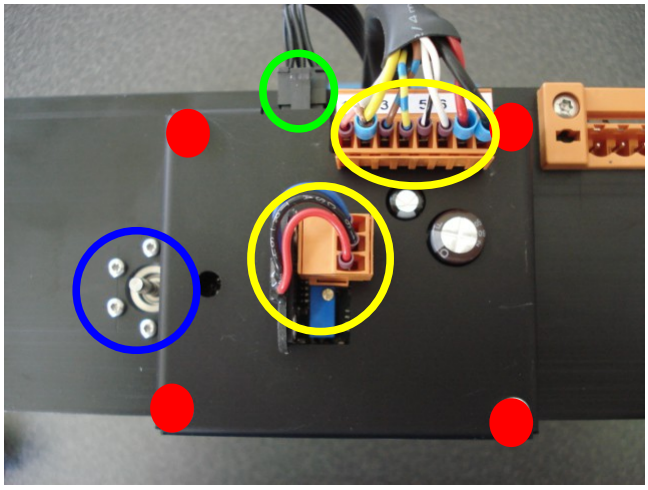


To get access to the pre-amplifier-board, the filter wheel has to be removed. For this the screw (yellow) has to be loosened and the filter wheel has to be removed from the motor axis.



Now the two orange plugs (yellow) have to be removed. The motor is connected to the electronics with a plug. To remove this plug (green), the screws (red dots) have to be removed to release the cover plate.
Now the plug (green) can be removed.
For this please push on the rocker switch.

Now the 4 screws M2x5 (blue) can be removed by using a Torx (T5) screwdriver.



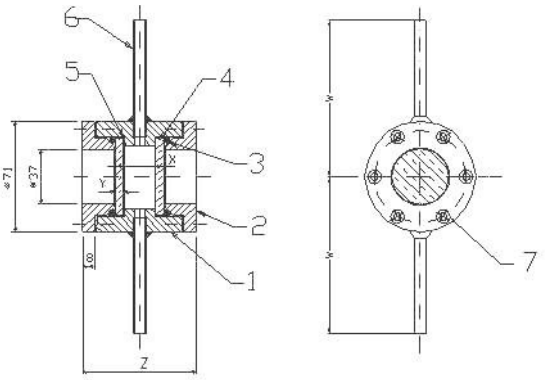
Then the cover of the pre-amplifier board can be pushed. To replace the board, you have to unscrew the stay bolts. After this you can remove the board and replace it.

The assembly can be done by following the disassembly procedure backwards.

10.5 Cleaning the flow cell

The flow cell sometimes requires maintenance due to materials that adhere to the cell windows. This can be seen by a continuous drift or a film on the cell windows.

This film can only be seen by using an angle mirror. For this reason, the cell windows have to be cleaned occasionally. This chapter will describe this procedure. In case of extreme pressure variations, the density of the flow cell has to be controlled.

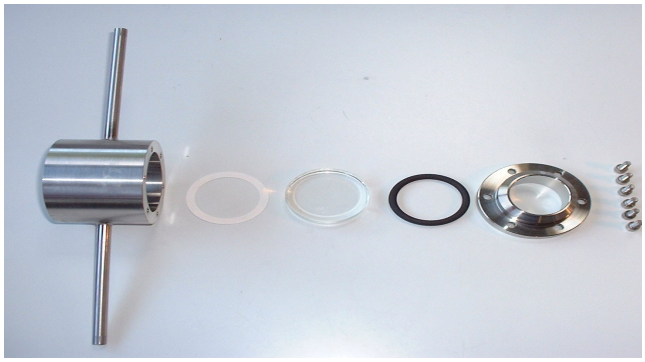


1. Cell body
2. Cell flange
3. O-Ring
4. Cell window
5. Ring (mat. Teflon)
6. Connection pipe
7. Screws DIN6912

Flow cell

ATTENTION:
Before opening the flow cell, it has to be made sure that the cell is unpressurized and does not contain any hazardous material!

To separate the cell flange of the cell body, the six screws (M5 with hexagon socket SW4) have to be opened. It is reasonable to do this in a crossing sequence. Once the flange is removed, the o-ring, cell windows and the Teflon o-ring can be removed, too. After cleaning, the parts can be re-assembled in the same sequence backwards. Be very careful during re-assembly because otherwise leakages can occur. The screws have to be to turned in a crossing sequence and with constant torque of approx. 1 Nm. When finished, a small crack of approx. 1 mm will be between the cell flange and the cell body (depending on the o-ring material).



Flow-cell body with separated components

11 Index

