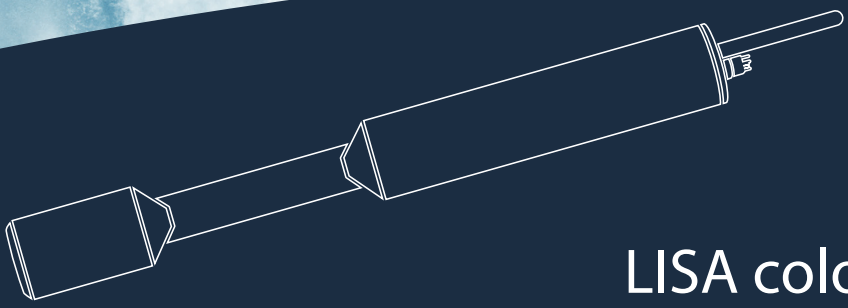
TriOS
Optical Sensors



LISA color

OPERATING INSTRUCTIONS

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1 General Information

1.1 Introduction

Welcome to TriOS.

We are glad that you have chosen to purchase the LISA color immersion sensor.

The LISA color uses two different LEDs for long-term stable measurement of the SAC, or color at different wavelengths. The first channel is the nominal wavelength, which is used to determine the type. The second channel is used for turbidity or background correction. Equipped with the innovative G2 interface that has a web browser configuration, internal data logger, flexible protocols and data outputs, the LISA color has features that are significantly better than the other devices currently available on the market.

In this manual, you will find all the information you will need to commission the LISA color. Technical specifications, as well as detection limits and dimensions can be found in chapter 7.

Please note that the user is responsible for complying with local and national regulations on the installation of electronic devices. Any damage caused by incorrect use or unprofessional installation will not be covered by the warranty. All sensors and accessories supplied by TriOS Mess- und Datentechnik GmbH must be installed and operated in accordance with the specifications provided by TriOS Mess- und Datentechnik GmbH. All parts were designed and tested in accordance with international rules for electronic instruments. The device meets the requirements of the international regulations on electromagnetic compatibility. Please use only original TriOS accessories and cables to ensure reliable and correct operation of the devices.

Before using the device, read the manual carefully, and keep this manual on hand so it can be used later. Before commissioning the sensor, please make sure that you have read and understood the following safety precautions. Always make sure that the sensor is correctly operated. The safety precautions described on the following pages should ensure the reliable and correct operation of the device and any additional associated devices and should prevent injuries to yourself or other persons and damage to other equipment.

NOTICE	**If the translation is at all different from the original German text, the German version is binding.**

Software Updates

This manual refers to software version 1.0.2 and higher. Updates include bug fixes, new features and options. Devices with older software versions may not have all functions described here.

Copyright Notice

1.2 Health and Safety Information

This manual contains important information about health and safety rules. This information is labelled according to the international specifications of ANSI Z535.6 (“Product safety information in product manuals, instructions and other collateral materials”) and must be strictly followed. The distinction is made between the following categories:

⚠ **DANGER**	**Danger warning / will lead to serious injury or death**
⚠ **WARNING**	**Warning / may lead to serious injury or death**
⚠ **CAUTION**	**Caution / may cause moderate injury**
NOTICE	**Can result in damage to property**

Tip / Useful Information

Electromagnetic waves

Devices that radiate strong electromagnetic waves can influence the measurement data or result in a malfunction of the sensor. Avoid using the following devices in the same room as the TriOS sensor: mobile phones, cordless phones, transmitters/ receivers and other electrical devices that produce electromagnetic waves.

⚠ **CAUTION**	**Never look directly into the light source without suitable UV protection! UV light can irreversibly damage your eyes.**

Reagents

Follow the safety and operating instructions of the manufacturer when using reagents. Observe the valid Hazardous Materials Ordinance for reagents (German GefStoffV)!

Biological safety

Liquid waste may be biologically dangerous. Therefore, you should always wear gloves when working with such materials. Please observe the currently valid biological agents regulation (German BioStoffV)!

Waste

When handling liquid waste, the regulations on water pollution, drainage and waste disposal must be observed.

1.3 Warnings

- This sensor has been developed for use in industry and science. It should only be used for the measurement of aqueous solutions, e.g., process waste water, river water or sea water.

NOTICE **Stainless steel sensors are not intended for use in sea water or in high chloride concentrations (corrosion). Only sensors made of titanium can be used in these waters.**

- Sensors made from stainless steel must be cleaned immediately after coming in contact with salt water or other corrosive substances (e.g., acids, alkalis and chlorine-based connections). The material resistance should be checked after every use.
- The sensor has seals made from NBR (nitrile butadiene rubber). Sealing rings made from other materials may be used upon individual request. Before operation, please ensure that the measured medium does not damage the seals.
- Do not cut, damage or change the cord. Make sure that no heavy objects are placed on the cord and that the cord is not folded. Make sure that the cord is not run near hot surfaces.
- If the sensor cable is damaged, it must be replaced with an original part by the customer service of TriOS Mess- und Datentechnik GmbH.
- Do not place unsuitable items in the optical path when the measurement process is in operation, because this can cause damage to the sensor or incorrect measurement results.
- Stop operation of the sensor if excessive heat develops (i.e., if it is hot to the touch). Switch off the sensor immediately and unplug the power cord from the power supply. Please contact your dealer or TriOS customer service.
- Never try to disassemble or modify a part of the sensor if such a procedure is not explicitly described in this manual. Inspections, modifications and repairs may only be done by the dealer or by qualified experts authorized by TriOS.
- Devices from TriOS Mess- und Datentechnik GmbH meet the highest safety standards. Repairs to the device (that involve the replacement of the connecting cable) must be carried out by TriOS Mess- und Datentechnik GmbH or a workshop authorized by TriOS. Faulty, improper repairs can result in accidents and injuries.

NOTICE **TriOS does not guarantee the plausibility of the measured values. The user is always responsible for the monitoring and interpretation of the measured values.**

1.4 Users and Operating Requirements

The LISA color photometer has been developed for use in industry and science. The target group for the operation of the LISA color SAC probe is technically skilled staff in plants, sewage treatment plants, water plants and institutes. The use of this device often requires the handling of hazardous substances. We assume that the operating personnel are familiar with dealing with dangerous substances based on their professional training and experience. The operating personnel must be able to correctly understand and implement the safety labels and information on the packaging and in the package inserts of the test kits.

1.5 Intended Use

The purpose of the LISA color is exclusively the implementation of SAC or transmission measurements as described in this manual. For this purpose, the photometer is an immersion sensor, which is used underwater or with flow cells. Please note the technical data of the accessory parts. Any other use is not considered to be in compliance with the intended use.

The sensor may only be used to measure the SAC and transmission of aqueous fluids, such as process wastewater, municipal wastewater and the surface/groundwater. The use of other media can damage the sensor. For the use of the LISA color in other media then those specified this manual, please contact the customer service of TriOS Mess- und Datentechnik GmbH (support@trios.de).

NOTICE	**Avoid any unnecessary contact with the glass parts in the optical path, as they can be scratched or soiled. This means the functionality of the device can no longer be guaranteed.**

According to current scientific knowledge, the device is safe to use when it is handled according to the instructions in this user manual.

NOTICE	**Damage caused by improper use is excluded from the warranty.**

1.6 Disposal Instructions

At the end of the device's life or use, the device and its accessories can be returned to the manufacturer for environmentally friendly disposal for a fee. (See address below). The preceding professional decontamination of the device must be proven with a certificate. Please contact us before you send the device back to get more details.

Address of the manufacturer:

TriOS Mess- und Datentechnik GmbH
Bürgermeister-Brötje-Str. 25
D-26180 Rastede
Germany
Tel.: +49 (0) 4402 69670 - 0
Fax: +49 (0) 4402 69670 – 20

1.7 Certificates and Approvals

This product meets all of the requirements of the harmonized European standards. It therefore meets the legal requirements of the EU guidelines. TriOS Mess- und Datentechnik GmbH confirms the successful testing of the product by affixing the CE marking. (See annex).

2 Introduction

The parameters of each LISA color photometer are directly dependent on the nominal wavelength of the device. Therefore, an SAC_{436} probe has an LED with a nominal wavelength of 436 nm, which cannot be changed. There are also “digital” and “analog” versions of the LISA color. There are eight different versions of the LISA color to choose from depending on the application, because the parameters cannot be changed.

2.1 Product Identification

All TriOS Mess- und Datentechnik GmbH products have a label, which clearly shows the product designation.

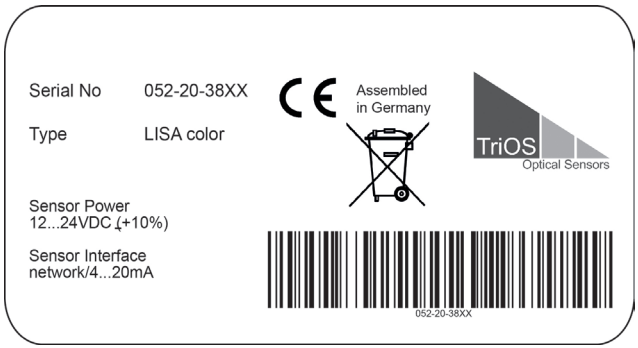
There is also a rating plate on the sensor with the following information that you can use to uniquely identify the product:

Serial number

Product type

Power supply

Interface



In addition to the product bar code, the rating plate includes the TriOS Mess- und Datentechnik GmbH logo and the quality label CE.

Please note that the specifications given here are for illustration purposes only and may be different depending on the version of the product.

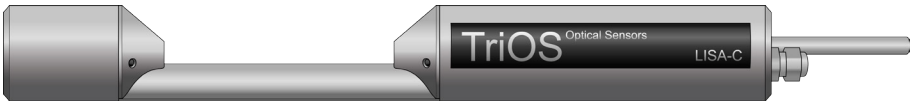
2.2 Scope of Delivery

The shipment contains the following components:

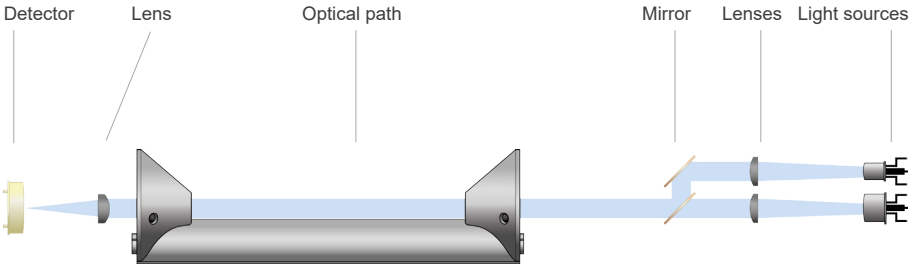
1. Sensor
2. Operating instructions
3. Accessories (if applicable)

Keep the original device packaging in case the device needs to be returned for maintenance or repairs.

2.3 Measurement Principle and Design



For optimal use of the sensor, you must know and understand the idea and theory that the sensor is based on. The following is an overview of the measurement principle, the optical arrangement and the subsequent calculation.



Essentially, the LISA color has four parts: a defined light source, a lens system, the optical path through the medium and the detector with ambient light suppression. The arrangement of these parts is represented schematically in the illustration above.

The light source consists of two LEDs of different wavelengths. The wavelength of the first LED (LED 1) depends on the application of the sensor. The wavelength of the second LED (LED 2) is 740 nm. The wavelength of LED2 is used for turbidity correction. Both LEDs are connected one after the other in a special profile. The light emitted by the LEDs passes through the medium to the detector and is partially weakened by the medium. The detector measures the Intensity (*I*) of the remaining light.

The weakening of the light caused by passing through the measurement medium is compared to the weakening of the light caused by passing through ultra-pure water. The measurement in ultra-pure water provides the so-called basic intensity (I_0). Using Equation 1 and Equation 2, the LISA color determines the transmission (*T)* and the absorbance *(A)* of both of the wavelengths mentioned above.

$$T = \frac{I}{I_0}$$

Equation 1: Calculation of transmission

$$A = -log_{10} T$$

Equation 2: Calculation of absorbance

where:

T	Transmission in %
I	current light intensity
I_0	basic light intensity in ultra-pure water
A	absorption in AUs (AU = absorbance unit)

The light intensity of the LEDs often varies with the temperature. Therefore, a temperature correction factor is determined for each wavelength of the LISA color and is used to calculate the measurement value.

2.3.1 Spectral Absorption Coefficient SAC

The LISA color outputs the SAC of the wavelength of LED 1. This will be the noted with SAC_{xxx} in the following. xxx represents the wavelength of LED 1. The absorption at the wavelength of LED 1 will be denoted with A_{xxx}.

The scattering of light on particles in a solution is seen as turbidity by the observer. The LISA color uses the absorbance of 740 nm (A_{740}, *LED 2*) for the turbidity correction of the absorption measurement of the wavelength emitted by LED 1 (A_{xxx}). The SAC of the specific wavelength of LED 1 is calculated using Equation 3 where d is the optical path length in millimetres [mm]. Path lengths of 50, 100, 150 and 250 mm are available for the LISA color.

$$SAC_{xxx} = \frac{(A_{xxx} - A_{740}) * 1000}{d}$$

Equation 3: Calculation of the spectral absorption coefficient at nominal wavelength xxx

where:

d	length of the optical path in millimetres [mm]
SAC	spectral absorption coefficient in [1/m]

2.3.2 Parameters

The LISA color uses two different LEDs for long-term stable measurements of SAC values or color numbers at different wavelengths. The following parameters (see table) are detectable with the appropriate model of LISA color. Some applications work with a factor to scale the SAC at certain wavelength to a specific parameter.

Parameters	Unit	Factor	LED 1 [nm]	LED 2 [nm]	According to
SAC_{436}	1/m	-	436	740	DIN EN ISO 7887:2011_method B
SAC_{525}	1/m	-	525	740	DIN EN ISO 7887:2011_ method B
SAC_{620}	1/m	-	620	740	DIN EN ISO 7887:2011_ method B

Parameters	Unit	Factor	WL-LED 1 [nm]	WL-LED 2 [nm]	According to
True color 410	mg/L Pt	18.52	410	740	DIN EN ISO 7887:2011_ method C
Pt-Co color 390	mg/L Pt	7.4	390	740	DIN EN ISO 6271-2016:05
Pt-Co-Color 455	mg/L Pt	36.4	455	740	DIN EN ISO 6271-2016:05
Cr-Co color 380	°(color degree)	9.7	380	740	no standard available
Cr-Co color 413	°(color degree)	34.1	413	740	GOST 3351-74

DIN EN ISO 7887:2011

The DIN EN ISO 7887:2011 standard describes the “Examination and determination of color”.

Method B of this standard describes the determination of true color using optical devices. The determination wavelengths are 436 nm, 525 nm and 620 nm. The method is applicable to untreated water, potable water and light-colored industrial wastewater.

Method C describes the determination of true color using optical devices for the determination of absorbance at the wavelength of 410 nm. The color solution for calibration consists of potassium hexachloroplatinate and cobalt chloride.

The LISA color measures the true color at 410 nm and the spectral absorption coefficients SAC_{436}, SAC_{525} and SAC_{620}, directly in the medium, depending on the version. Filtering the water is not necessary, because the absorbance of a wavelength of 740 nm is used for turbidity correction.

DIN EN ISO 6271:2016_APHA / Hazen_Pt-Co color number

The DIN EN ISO 6271 standard defines a spectrophotometric method of evaluating the color of clear liquids using the platinum-cobalt color scale. It is usable for clear liquids with color characteristics similar to those of the platinum-cobalt reference scale.

The term “platinum-cobalt color number” used in the standard is preferred to “Hazen color number” and “APHA color number”.

The Pt-Co scale is defined as a classification of the color of a solution that contains platinum in the form of hexachloroplatinate(IV) ions and cobalt(II) chloride hexahydrate in certain concentrations.

The recommended path length is 50 mm. The measurement range covers Pt-Co color numbers 0 to 500.

The LISA color measures the color number at 390 nm or 455 nm directly in the medium, depending on the version. Filtering the water is not necessary, because the absorbance of a wavelength of 740 nm is used for turbidity correction.

GOST 3351-74_Cr-Co color

The GOST 3351-74 standard method of the Russian Federation describes a photometric method to determine the presence of color in drinking water. The color scale is created using mixtures of potassium dichromate and cobalt sulphate in diluted sulphuric acid. Color levels are defined from 0 to 70°. The color is determined using a color measurement device with path lengths from 50 to 100 mm. The optical density of the filtrate of the water sample is measured in the blue range of the spectrum at 413 nm.

The LISA color measures the color at 413 nm directly in the medium. Filtering the water is not necessary, because the absorbance of a wavelength of 740 nm is used for turbidity correction.

2.4 Browser

Every version of the LISA color has a web interface that can be used to configure and calibrate the sensor. To access the web interface, you will need the G2 InterfaceBox and an Ethernet-capable device with a web browser, e.g., a notebook / laptop.

Open one of the following URLs (depending on the network structure) in your web browser:

http://lisa-color/

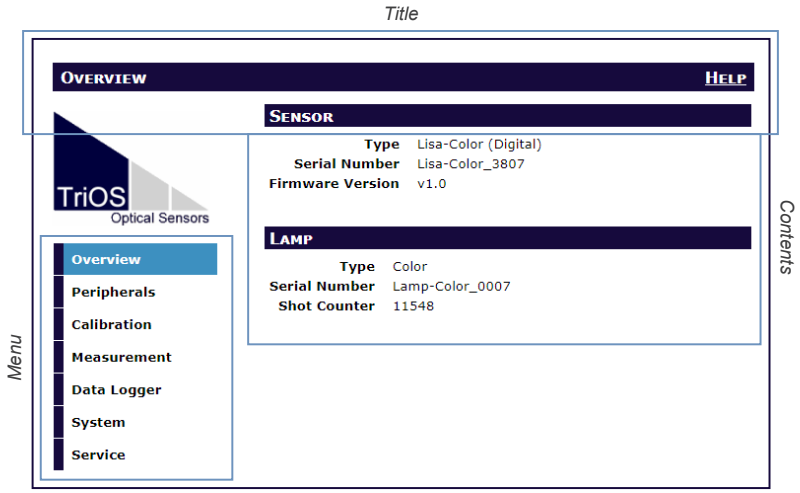
http://lisa-color_3XXX/ (3XXX is the serial number)

http://192.168.77.1/

When connected to an internet-capable device, automatic measurements will be stopped. As soon as the sensor is disconnected from the internet-capable device, the measurements will continue at the set interval if the timer is activated for automatic measurements.

The web interface is divided into three areas (see figure):

Title, menu and contents.



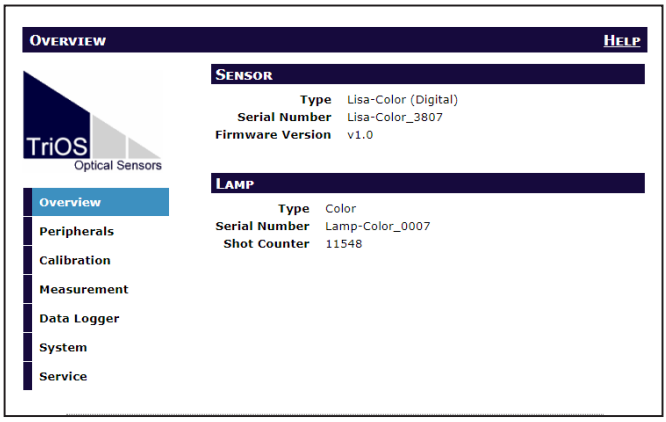
In the menu on the left, the subpoints are listed. There is a “Help” link on the right side that will take you to the TriOS Mess- und Datentechnik GmbH website. An active internet connection is required to access the website.

The menu is used to navigate the web interface. Each line is a link to another page with different setting options. The link that refers to the page that is currently displayed is always highlighted in the menu. some of the contents and functions are reserved for the employees of TriOS Mess- und Datentechnik GmbH Customer Service. Authentication is needed to access this content. This content is not accessible to every user.

The Contents area displays the relevant information and setting options. Contents that require authentication are deactivated (“grayed out”).

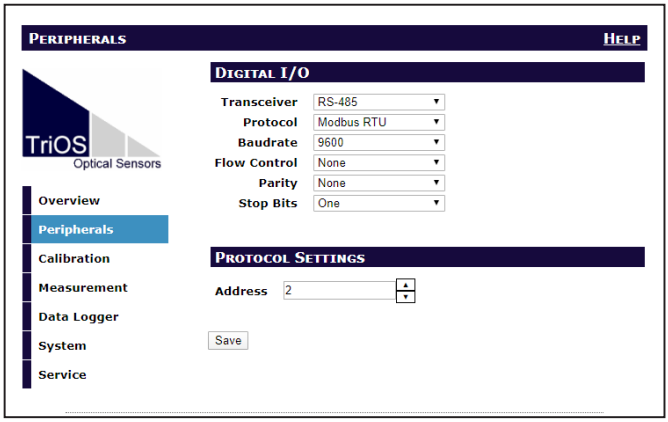
Overview

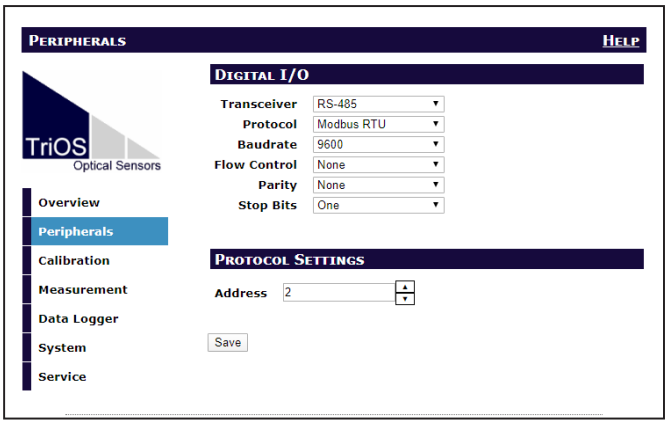
As shown in the following illustration, basic information about the sensor is summarized on the “Overview” page. This includes the device type and serial number of the sensor as well as the version number of the firmware installed. The type of lamp module, the lamp serial number as well as the number of measurements that have been carried out by this lamp module are listed.



Peripherals

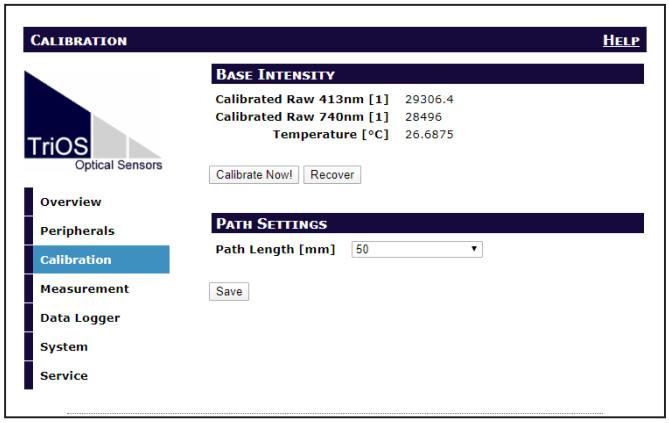
In the environment settings (“Peripherals”), various options are available depending on the version of the sensor output.





Calibration

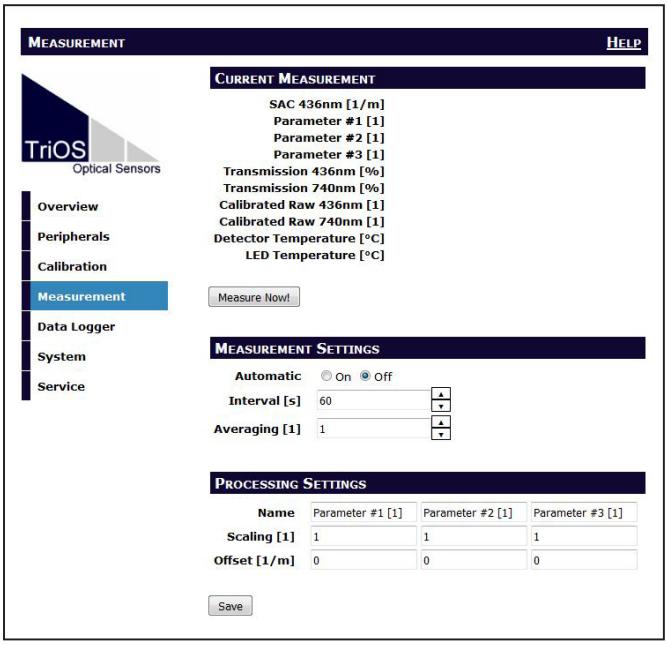
On the “Calibration” page, the zero value for the sensor can be calibrated and the optical path length can be entered.



Measurement

The “Measurement” page shows the results of the last measurement as well as the interval settings for the automatic measurements and the amount of individual measurements which will be the basis of the average measurement value for the final measurement. On this page, it is also possible to scale the measured value for the SAC_{xxx} [1/m] to the wanted parameters with the help of entries for “Offset” and “Scaling”.

A new measurement can be triggered at any time. To do this, click on the “Measure Now!” button. A new measurement will then be done with the saved settings. The parameters that are recorded include:



The sample view shows the values of the following parameters:

- SAC xxx nm [1/m] – absorption coefficient at xxx nm in 1/m
- Parameter #1 [1] – factory-set parameters dependent on the sensor application
- Parameter #2 [1] – freely configurable parameters
- Parameter #3 [1] – freely configurable parameters
- Transmission xxx nm [%] – transmission value at xxx nm in %
- Transmission 740nm [%] – transmission value at 740 nm in %
- Calibrated Raw xxx nm [1] – temperature-corrected raw value at xxx nm
- Calibrated Raw 740 nm [1] – temperature-corrected raw value at 740 nm
- Detector Temperature [°C] – temperature on the detector in °C
- LED Temperature [°C] – temperature of the LEDs in °C

The time interval for automatic measurements is entered in the field for “Interval[s]”. This interval is the minimum value. If the previous measurement has not been completed after the interval has elapsed (e.g., because the LISA color simply needs more time to calculate the average), this previous measurement will be completed, and the next measurement will be started as soon as possible.

The default and recommended measurement interval is 60 seconds.

If several individual measurements should be averaged to calculate the result, this can be set up in the “Averaging [1]” field. Enter the number of measurements to include in the result here.

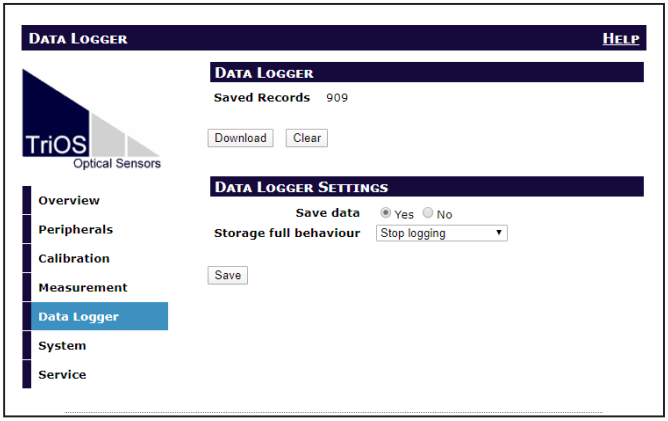
The SAC_{xxx} parameter [1/m] can be calculated automatically with a scaling factor and an offset for specific parameters. The scaling factor depends on the application and must be determined by the user, with the exception of the parameters predefined by the manufacturer. The values are entered in the corresponding “Scaling” and “Offset” fields. More information on the scalable parameters can be found in chapter 5.2 - Customer Calibration.

Important: Modified values must be saved by clicking on the “Save” button in order for the new values to be used for subsequent measurements.

Data Storage

The LISA color is equipped with a data logger function that allows it to save approximately 28,000 measurements. The data logger function is controlled on the “Data Logger” page, which is shown in the following figure.

Data logging is started by activating “Save data”. In normal operation, every measurement is stored until the memory is full. The default measurement interval is 60 seconds, which means that the data logger will record measurements for approximately 530 hours (22 days). If “Delete oldest data” is selected under “Storage full behavior”, old data is overwritten with new data when the data log is full.

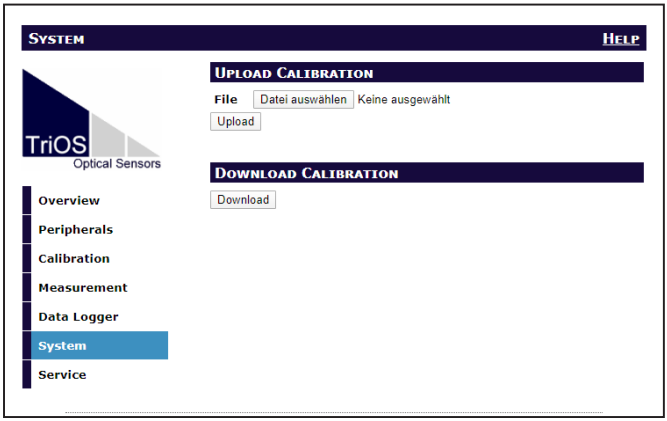


Previously stored data can be retrieved by clicking on the “Download” button. The data is saved as a CSV (comma-separated values) file, which can be read by spreadsheet software.

To delete the stored data, click on the “Clear” button. If the subsequent confirmation prompt is confirmed, all of the previously stored measurements will be deleted.

System

The “System” page is used to manage the sensor. On this page, the user can load a calibration file and download the current calibration as a restore point.



Service

To use the Service function, you need a login and a password. You will receive a login and password when you participate in a TriOS training session.

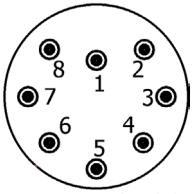
3 Commissioning

This chapter deals with the commissioning of the sensor. Please pay particular attention to this section and follow the safety precautions to protect the sensor from damage and yourself from injury.

Before the sensor is put into operation, it is important to ensure that it is securely attached and all of the connections are connected correctly.

3.1 Electrical Installation

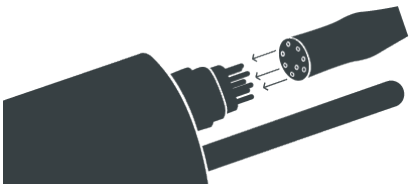
3.1.1 SubConn 8-pin Connector



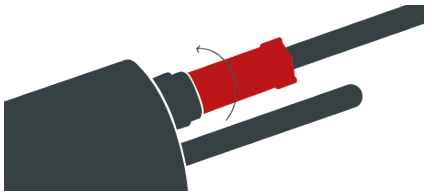
Face view (male)

DIGITAL VERSION	ANALOG VERSION
1. Ground (Power + Ser. Interface)	1. Ground (Power + Ser. Interface)
2. RS232_RX / RS485_A (commands)	2. analog out (4...20 mA)
3. RS232_TX / RS485_B (data)	3. not connected
4. Power (12...24 VDC)	4. Power (12...24 VDC)
5. ETH_RX-	5. ETH_RX-
6. ETH_TX-	6. ETH_TX-
7. ETH_RX+	7. ETH_RX+
8. ETH_TX+	8. ETH_TX+

Connect the male end of the cable to the connector by aligning the pins with the slots of the cable.

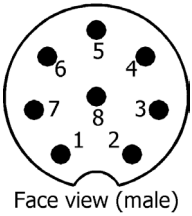


The next step is to rotate the locking sleeve in a clockwise direction to lock the end of the connector into the bulkhead connection.



NOTICE **Do not twist or bend the connector when plugging or unplugging it. Insert the connector straight in and use the locking sleeve to attach the male contact pin.**

3.1.2. Fixed Cable with M12 Industrial Plug



Face view (male)

DIGITAL VERSION	ANALOG VERSION
1. RS232_RX / RS485_A (commands)	1. analog out (4...20 mA)
2. RS232_TX / RS485 B_(data)	2. not connected
3. ETH_RX-	3. ETH_RX-
4. ETH_RX+	4. ETH_RX+
5. ETH_TX-	5. ETH_TX-
6. ETH_TX+	6. ETH_TX+
7. Ground (Power + Ser. Interface)	7. Ground (Power + Ser. Interface)
8. Power (12...24 VDC)	8. Power (12...24 VDC)

NOTICE **Ensure correct polarity of the operating voltage or the sensor may be damaged.**

3.2 Interfaces

3.2.1 Serial Interfaces

The **"digital" version** of the LISA color provides two lines for digital, serial communication with a control device. The "digital" version has a configurable digital, serial interface. The RS232 (and EIA 232) and RS485 (and EIA 485) standards are supported, and the web interface allows switching between the two standards.

The digital RS232 and RS485 interfaces are voltage interfaces (not a current interface, which is the case with the analog output of the "analog" version). For the RS232, voltages of –15 V to +15 V with respect to ground are possible. For the RS485, voltages of –5 V to +5 V with respect to ground are possible.

Upon delivery, the LISA color is configured to RS485 with the following settings:

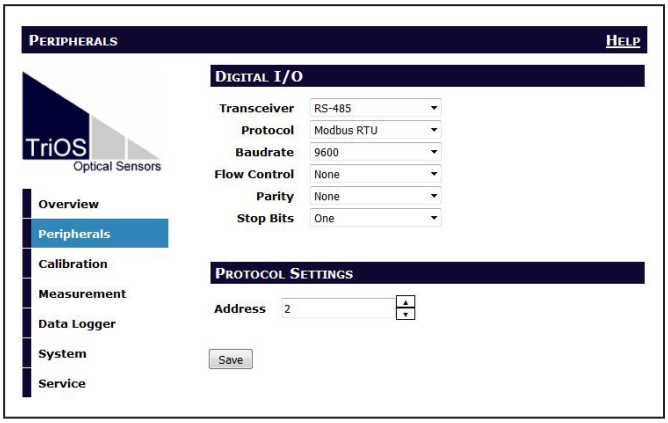
- Baud rate: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity: none

A detailed description of the Modbus RTU protocol commands can be found in the annex.

For the RS232, data transmission occurs on one line per direction, with the RX cable being used for the communication from the control device to the sensor and the TX cable being used from the sensor to the control device.

RS485 uses a differential signal where the sign-negative potential of the A line is put on the B line. The A-B difference is decisive, where the transmission is most resistant to interactive interference signals.

For the "digital" version, the "Peripherals" page of the web interface allows configuration of the digital interface. The setting options are shown in the following figure:



- Transceiver: Here you can select the electrical connection standard. The available choices are:
    - RS232 (and EIA 232)
    - RS485 (and EIA 485)

- Protocol: Specifies the data protocol to be used. Supported:
    - Modbus RTU
- Baud rate: Specifies the transmission speed.

Note: In the event of difficulties in the communication, reduce the baud rate.

- Flow control: Activates flow control on the software level (XON/XOFF).

Note: Flow control is only supported with the internal TriOS data protocol and must be deactivated when using the Modbus RTU.

- Parity: activates the parity check for data transmission. The options are:
    - None (deactivated)
    - Even
    - Odd
- Stop bits: Specifies the number of stop bits.

Note: In various Modbus devices, it may be necessary to set this to "Two" if a parity check does not need to occur.

In the "Protocol settings" section, you can input settings for the active protocol.

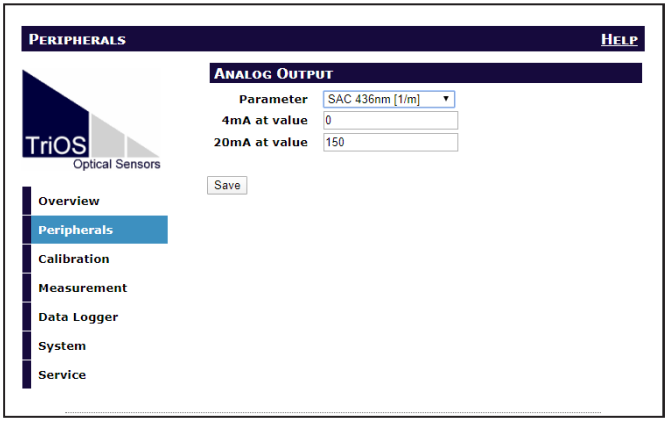
- In the Modbus RTU protocol, the following properties are also available:
    - Address: This is the slave address for the Modbus communication. It identifies the sensor in the bus system and must be unique.

3.2.2 Analog Interfaces

The **"Analog version"** of the LISA color uses a current regulator for the analog output. This offers the advantage that the signal is not distorted by the internal resistance of the cable even over long distances, which would be the case with a voltage regulator. The analog output is only available in the "analog" version of the sensor. The analog current at the analog output represents the measured value of the set parameter of the last measurement. The analog current is always 4 mA to 20 mA. The 4...20 mA analog current at the analog output is linear in relation to the measurement range. To convert the values of the mA analog output into SAC [1/m], the following formula must be used:

$$SAC = \frac{analog\ value[mA] - 4[mA]}{16[mA]} \cdot upper\ limit\ of\ the\ measurement\ range^{*}$$

*For the SAC, the path length must be considered when determining the upper limit of the measurement range (see table p. 20).



The **"analog" version** offers three options on the "Peripherals" page of the web interface: the parameter to represent at the output as well as the lower and upper limits for the linear spread of the measurement value from 4 mA to 20 mA (see figure p. 11 below).

- Parameter: the measured parameter that should be represented at the analog output, is set. The parameters available for selection depend on the lamp module type used, the firmware version as well as other details.
- 4 mA at value: Specifies the lower limit of the measurement value.
- 20 mA at value: Specifies the upper limit of the measurement value.

Important: To apply modified values, they must be saved by clicking on the "Save" button.

NOTICE **Observe the measurement ranges of the parameters as a function of the path length of the sensor!**

Output parameters SAC_{xxx}

The analog version of the sensor checks the current at the analog output. The analog current is always within the range of 4mA to 20mA.

In the table, the measurement range SAC_{xxx} [1/m] depends on the path length, which must be considered when configuring the analog output.

Path length [mm]	Measurement range SAC_{xxx} [1/m]
50	0...30
100	0...15
150	0...10
250	0...6

The default setting for the analog output for a 50-mm path is configured as follows:

- SAC_{xxx} = 0 [1/m] corresponds to 4 mA
- SAC_{xxx} = 30 [1/m] corresponds to 20 mA

Output parameter transmission

The default setting for the analog output for transmission is configured as follows:

100 % transmission = 20 mA

0 % transmission = 4 mA

3.2.3 Network

For the new TriOS G2 sensors, the IEEE 802.3 10BASE-T-compliant Ethernet interface is used as a universal interface. This makes it possible to connect a single sensor or even to build a complex sensor network.

Network with a single G2 sensor

The easiest way to connect to the LISA color is with the G2 InterfaceBox. The G2 InterfaceBox is both the connection and the power supply for the sensor and can be used with all of the TriOS G2 sensors.

The following figure shows a connection to a single sensor:

G2 sensor | G2 InterfaceBox | Ethernet-capable device

The TriOS G2 InterfaceBox adapts the 8-pin M12 sensor plug to the conventional power supply connections (2.1 mm barrel connector) and to the network connections (RJ45 socket).

G2 InterfaceBox

There are three connectors on the housing of the G2 InterfaceBox:

1. Power supply, 12 or 24 VDC; 2.1 mm barrel connector
2. Sensor connector 8-pin M12
3. Ethernet connection RJ45 socket

Proceed as follows to connect the sensor to an Ethernet-capable device via the G2 InterfaceBox:

Step 1) Make sure that the Ethernet adapter of your device is configured to automatically obtain the network settings (IP address and DNS server).

Step 2) Plug the M12 plug of the sensor cable into the M12 socket (2) of the G2 InterfaceBox and tighten the screw plug.

Step 3) Connect the 12 or 24 VDC power supply to the G2 InterfaceBox to supply power to the sensor.

Step 4) Wait at least 3 seconds before you connect your Ethernet LAN cable with your Ethernet-capable device and the G2 InterfaceBox.

The web interface can now be accessed with any browser using the following URLs:

http://lisa-color/

http://lisa-color_3XXX/ (3XXX is the serial number)

http://192.168.77.1/

If the web interface cannot be accessed, make sure that the LAN cable was connected after the sensor was connected to the power supply and try all three URL options.

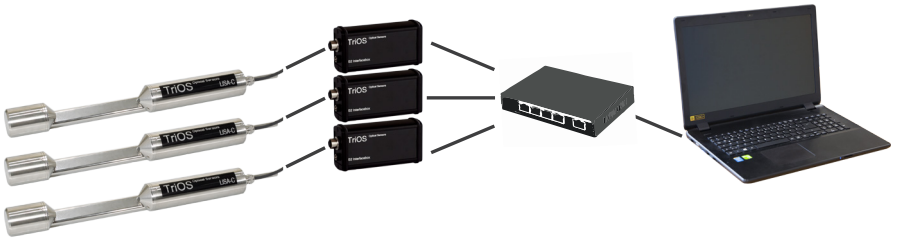
Automatic measurement by the LISA color is stopped when an Ethernet-capable device is connected. When the LAN connection between the sensor and the internet-capable device is disconnected, the measurements will continue at the set interval if the timer is activated.

Network with multiple G2 sensors

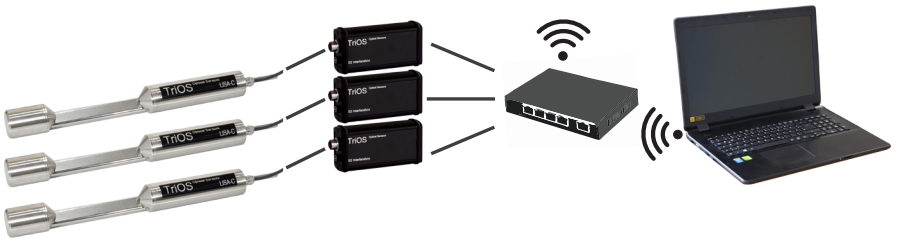
By using an Ethernet switch / hub or a conventional router, it is possible to connect multiple sensors into a complex network and use them simultaneously. In the sensor network, each sensor must have its own G2 InterfaceBox for a power supply.

Like any G2 sensor, the LISA color delivers a simple DHCP server as well as a simple DNS server, which is configured exclusively for a direct connection, as described in the previous section. For a complex sensor network, the servers must be supplied by the user. The LISA color recognizes these servers automatically and then turns off the internal servers. Ask your network administrator how a sensor network is best implemented in your case.

The following illustrations show examples of different ways to set up a sensor network.



G2 sensors	G2 InterfaceBox	a) Ethernet switch / hub b) Router with DHCP server	a) Ethernet-capable device with DHCP server b) Ethernet-capable device



G2 sensors	G2 InterfaceBox	a) Access point b) Wireless router with DHCP server	a) Wireless-capable device with DHCP server b) Wireless-capable device

The LISA color can only be used with one Ethernet-capable device at a time.

If multiple sensors are used in a network, the web interface can be accessed via the host name http://lisa-color_3XXX/ (3XXX is the serial number) or via the IP address. Ask your network administrator for advice.

NOTICE	**Damage caused by improper use is not covered by the warranty!**

4 Use

The LISA color can be operated with any of the TriOS controllers. Instructions for correct installation can be found in the controller manual.

NOTICE **Never transport the sensor by holding the cable.**

4.1 Normal Operation

4.1.1 Immersion Operation

For immersion operation, the LISA color can be completely or partially immersed in the water / measuring medium. To get a correct measurement, the measuring windows must be completely immersed and free of air bubbles. Use the mounting rod with a shackle and a stainless steel chain or a steel wire to hang the device in the medium. Do not add weight to or pull on the sensor cable. The LISA color can also be attached with suitable hydraulic clamps, as shown in the following illustration. Make sure to use suitable brackets with an inner diameter of 48 mm. To protect the housing pipe against excess spot pressure, install the brackets close to the device covers. Fitting brackets can be obtained from TriOS.

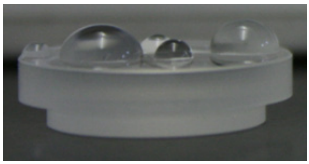
When immersing the sensor, make sure that there are no air bubbles in front of the sensor discs. If there are, shake the sensor carefully until the bubbles are removed.

4.1.2 Cleaning System

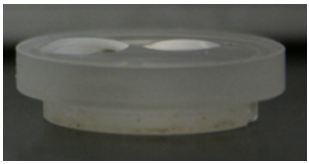
The LISA color and the other sensors from TriOS Mess- und Datentechnik GmbH have innovative antifouling technology that prevents pollution and dirt from attaching to the optical window: nano-coated window in combination with compressed-air cleaning.

Nano-coating

All of the optical windows from TriOS are treated with a nano-coating.



Window with nano-coating

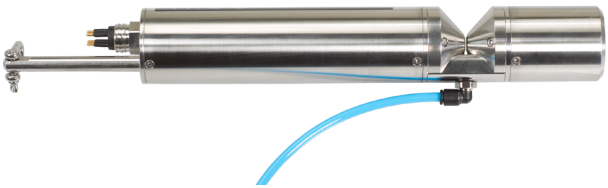


Window without nano-coating

Wetting of the surface of the coated glass is significantly lower. This effect is caused by the nano-coated surface of the glass, to which dirt cannot adhere. In combination with the compressed-air cleaning, the windows are kept clean for long periods of time so the amount of cleaning necessary is reduced.

Compressed air cleaning

LISA color can be modified for all path lengths between 50 and 250 mm with the optional compressed-air cleaning head. The head is equipped with an air outlet directly on the window plate of the device and a hose fitting for the compressed-air connection. TriOS controllers have valves that are controlled by software, which allows fixed cleaning intervals to be set. Compressed air of between 3 and 6 bars must be provided.



NOTICE	**The optimum pressure for compressed-air cleaning is 3 to 6 bars. The total length of the hose should not exceed 25 meters. Suitable hoses are available at TriOS (polyurethane, 6 mm outer diameter, 4 mm inner diameter).**

With compressed cleaning air for long paths, the angle pieces must be screwed into the holes provided in the center piece.

The hoses suitable for the path can then be connected to the Y-piece and the free ends of the hoses to the elbow fittings, as shown in the following figure.

The compressed air supply line is attached to the still free opening of the Y-piece.

Be careful not to set the air pressure above 6 bar.

Suitable materials for compressed air cleaning for long paths are available from TriOS.

To connect the hose, push the hose into the matching connection port. To remove the hose, press the blue locking ring in the direction of the connection and pull the hose out. Secure the hose to the device and the cable with cable ties if necessary to avoid uncontrolled hits and movement of the compressed-air hose.

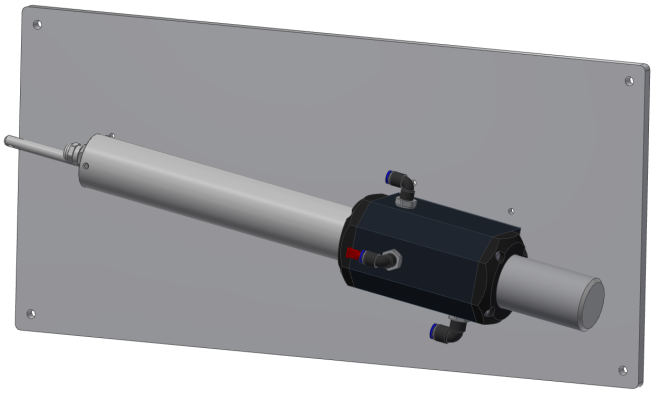
NOTICE	**The pressure should not exceed 7 bars because this may damage the valve!**

4.1.3 Float

The float is the ideal solution for fluctuating water levels.

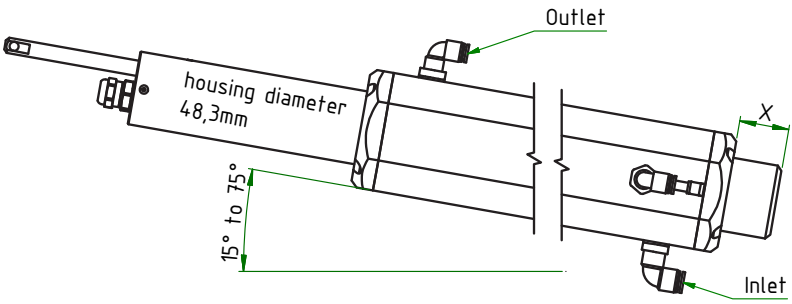
4.2 Bypass

With the optional flow cell, the LISA color can be installed as a bypass. Along with the flow cell, a panel is available on which the LISA color and the flow cell can easily be mounted.



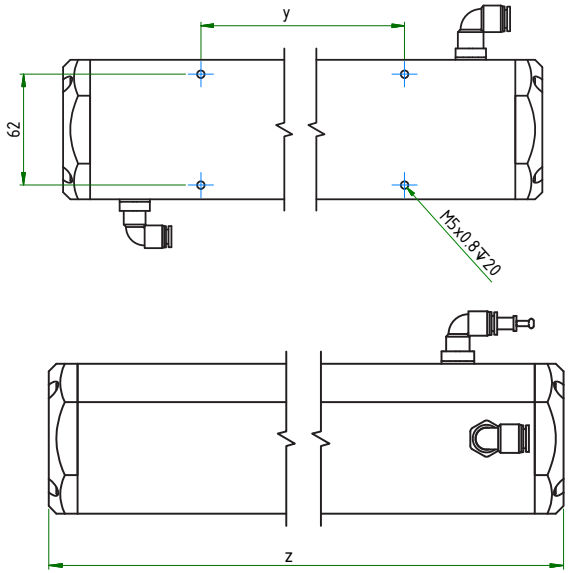
NOTICE **The maximum pressure in the flow cell must not exceed 1 bar. Make sure that the sensor is installed in the correct position to ensure the free flow of water.**

The flow cell of the LISA color has three hose connections. The inflow has an 8-mm hose connection and is located on the right side of the flow cell. There is a 6-mm outlet hose connection on the left side of the cell. Finally, there is a third hose connection on the top of the cell for cleaning with fluids. If the third hose connection is not used, it should be sealed with a plug.



Because the LISA color is available in different path lengths, the dimensions of the associated flow cells vary accordingly, as described in the following table:

Path length [mm]	x [mm]	y [mm]	z [mm]
50	32.5	96	150
100	32.5	96	200
150	32.5	96	250
250	32.5	96	300

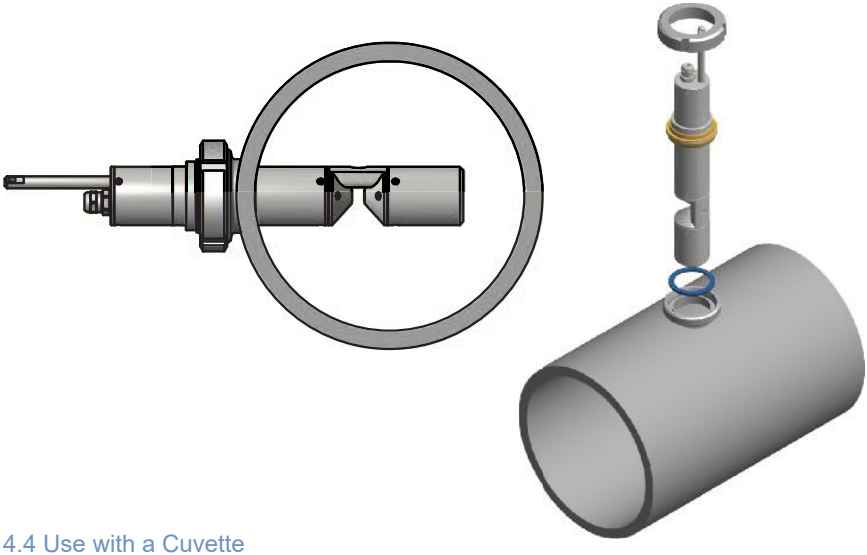


The hoses are installed by putting light pressure on the hose connectors. To remove the hoses, press on the locking ring on the hose connector and carefully pull the hose away.

NOTICE **The flow cell cannot be combined with the compressed-air cleaning.**

4.3 Pipe Installation

The LISA color can be mounted directly in the pipe (either with the special flanged version of the sensor or by the customer on-site). In the case of a grounded tube, no additional grounding of the sensor housing is required if there is no insulation between the tube and the sensor. One of the flange solutions available from TriOS is shown in the figure below.



4.4 Use with a Cuvette

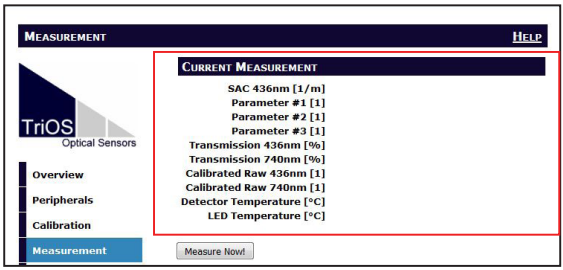
For laboratory measurements and very small quantities of water, the LISA color with a path length of 10 mm can be outfitted with a cuvette holder for standard 5-mm cuvettes.

To take measurements with cuvettes, a new zero value must be set. Before setting a new zero value, the current calibration should be downloaded and stored so that later it can be uploaded when using the sensor in the submerged state (see chapter 6.3.1 Restore Point).

5 Calibration

5.1 Manufacturer Calibration

All TriOS sensors are delivered calibrated. The calibration factors of the LISA color are stored in the sensor, meaning that all values that are output (digital or analog) are calibrated values.



The following parameters are predefined at the factory:

Parameter #1	Unit	Scaling factor
True color 410	mg/L Pt	18.52
Pt-Co-Color 390	mg/L Pt	7.4
Pt-Co-Color 455	mg/L Pt	36.4
Cr-Co-Color 380	°(color degree)	9.7
Cr-Co-Color 413	°(color degree)	34.1

The conversion of the spectral absorption coefficient to the scaled measurement parameter is done using the following equations.

The offset and scaling factor are stored in the sensor for the measurement parameter.

The manufacturer calibration of the sensor is carried out as follows:

- The offset is determined by measuring in ultra-pure water (free of humic and fulvic acid, 18.2 MΩcm water)

$$A = Raw - Offset$$

- The scaling factor for each measurement range is determined by using the respective calibration standard.

$$B = A \times lin$$

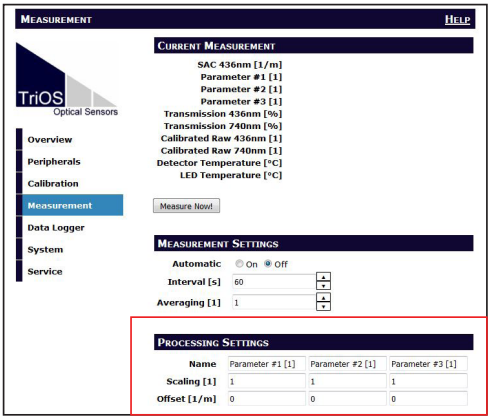
where:

A	offset corrected value
Raw	raw data
Offset	offset value
B	concentration of the substance in physical units
lin	scaling factor

The manufacturer calibration should not be changed!

5.2 Customer Calibration

The sensor can be adapted to laboratory analyses and local conditions with other calibration factors. This is set using the “Custom calibration” function of the controller or directly in the browser for the sensor. To do this, open the “Measurement” submenu in the browser. The customer calibration or local calibration supplements the manufacturer calibration. The manufacturer calibration values are not changed by the customer calibration.



The customer calibration can be used as a fine adjustment of the sensor for special media and supplements the manufacturer calibration.

Before recording measurement values, check the zero value of the sensor with the reference solutions. If necessary, determine a new zero value (see chapters 6.2.1 and 6.3.1).

The local calibration is adjusted using a linear equation. Two constants are required for this: the scaling factor and offset, which are used in the following equation:

$$A = SAC - Offset$$

$$B = A \times scaling$$

With *A* being the SAC output, which is provided by the LISA color.

A	Offset corrected value
Offset	Offset value
B	Customer-calibrated parameters

For local calibration, at least two data points, i.e., a laboratory value and a sensor value, are required. The easiest way to do this is to use a non-contaminated sample and a contaminated sample.

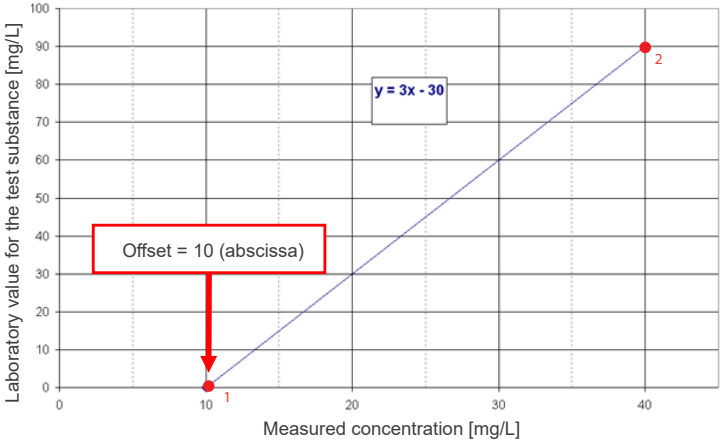
1. The non-contaminated sample is used to determine the offset. To do this, immerse the photometer in the fluid that is not contaminated. In this specific case, the signal gives the value of the offset directly for the local calibration.

   $$Offset = measuredvalue1$$

   If a non-contaminated sample is not available, the equation in step 5 below offers another option.

2. Immerse the sensor in the contaminated medium and record measuredvalue2, which is provided by the photometer. Do a laboratory analysis of the sample.

3. Make a diagram like the one shown below and connect the two data points with a straight line. The slope of the straight line is the scaling factor.



4. The scaling factor can be calculated using the following equation:

$$scaling\ factor = \frac{lab}{measuredvalue2 - offset}$$

With *lab* for the laboratory values and *measuredvalue* for the values provided by the sensor.

For the previous example in the figure, this means:

$$scaling\ factor = \frac{90\ \text{mg/L}}{(40 - 10)\ \text{mg/L}} = 3$$

5. If a non-contaminated sample is not available, at least two samples with very different levels of contamination are required. In this case, you will first calculate the scaling factor as follows:

$$scaling\ factor = \frac{(lab2 - lab1)}{(measuredvalue2 - measuredvalue1)}$$

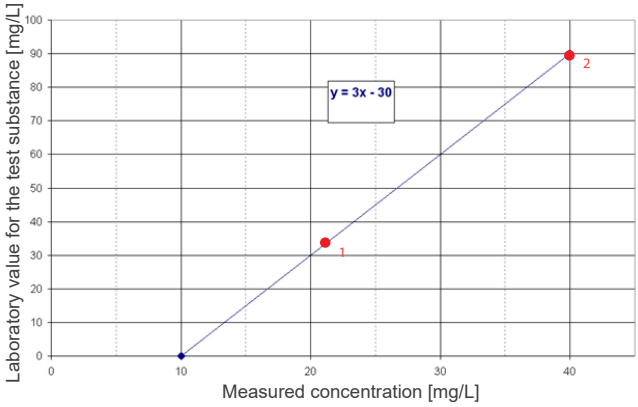
Calculation of the offset without a zero-point measurement (1.):

$$offset = measuredvalue2 - \frac{lab2}{Scaling\ factor}$$

measuredvalue2 should be significantly larger than *measuredvalue1*. The offset can also be found using the abscissa of the straight line (intersection with the X-axis). For the above example, this means:

$$scaling\ factor = \frac{90 - 30}{40 - 20} = 3$$

$$offset = 40 - \frac{90}{3} = 40 - 30 = 10$$



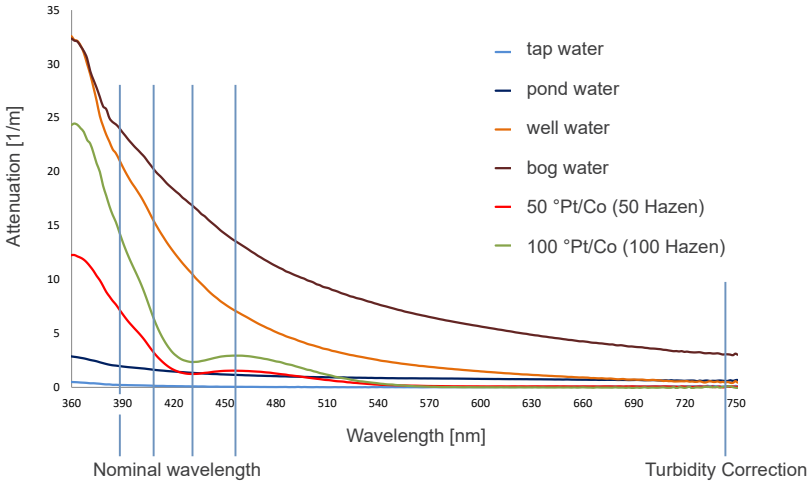
All of the TriOS controllers have the ability to set scaling factors and offset values for the measurement parameters. Please refer to the appropriate manual. Make sure not to do double scaling with the sensor: once in the G2 sensor menu directly and once more with the TriOS controller!

Customer calibration can be used as a fine adjustment of the sensor for special media and is not intended to replace the manufacturer calibration.

NOTICE **Measurement ranges and detection limits of the scaled parameters are dependent on the scaling factor!**

5.3 Measurement Properties

The coloring of different liquids is often nearly identical upon visual inspection, but spectral resolution allows clear differences to be detected.



6 Malfunction and Maintenance

To ensure an error-free and reliable measurement, the device should be periodically inspected and maintained. For this, the sensor must be cleaned first.

6.1 Cleaning and Upkeep

The deposits (vegetation) and dirt that collects on the sensor depends on the medium and the duration of exposure in the medium. Therefore, the degree of pollution depends on how the sensor is used. For this reason, it is not possible to give a general answer regarding how often the sensor should be cleaned.

Normally, the system is kept clean by the nano-coated window and also by the air cleaning system. If the contamination is too bad, the following instructions should be followed.

6.1.1 Cleaning the Housing

⚠ CAUTION **Please use protective goggles and gloves when cleaning the sensor, especially when using acids, etc.**

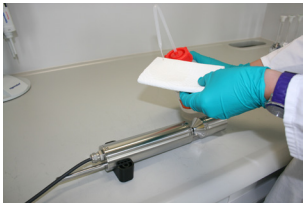
To loosen dirt, we recommend soaking the sensor for several hours in a rinsing solution. During cleaning, do not let the exposed connectors come in contact with water. To prevent contact with water, make sure that the locking cap of the connector is properly locked. Please learn about the risks and the safe handling of the cleaning solution used.

If the sensor is very dirty, additional cleaning with a sponge may be necessary. You should exercise extreme caution to avoid scratching the glass of the optical path.

In the case of calcification, a 10% citric acid solution or acetic acid can be used for cleaning.

Brownish dirt or spots can be contamination due to iron manganese oxides. For this type of contamination, a 5% oxalic acid solution or a 10% ascorbic acid solution can be used to clean the sensor. Please note that the sensor should only briefly come in contact with the acid, and then it should be thoroughly rinsed.

NOTICE **Under no circumstances should the sensor be cleaned with hydrochloric acid. Even very low concentrations of hydrochloric acid can damage the components made of stainless steel. In addition, TriOS Mess- und Datentechnik GmbH cautions against using strong acids, even if the sensor should have a titanium housing.**

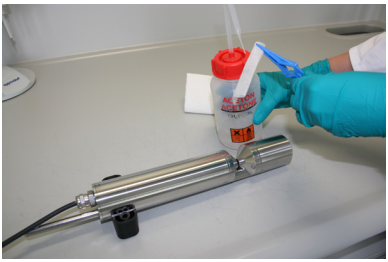




6.1.2 Cleaning the Measuring Window

You can clean the window with a few drops of acetone and a lint-free cloth, a clean paper towel or a special optical paper from TriOS Mess- und Datentechnik GmbH. Make sure that you do not touch the window surface with your fingers!

TriOS Mess- und Datentechnik GmbH sells a cleaning set that contains acetone and special optical cleaning paper to simplify cleaning the optical window.

NOTICE **Do not use any aggressive cleaning solutions, putty, sandpaper or cleaning solutions that contain abrasive substances to remove dirt.**



6.1.3 Preparing the Sensor for the Function Test and Zero Value Determination

Clean the probe as described in chapter 6.1.1 “Cleaning the Housing”. At the end of the cleaning process, rinse the probe carefully with deionized water. Dry the sensor with a paper towel. Wipe the sensor off with a small amount of acetone on a kitchen towel to remove any greasy residues.

⚠ CAUTION **For your own safety, you must wear the appropriate gloves and protective goggles!**

Clean the sensor window with special optical paper or a soft, lint-free cloth and a few drops of acetone according to the previous instructions on cleaning the measuring window.

Important: Next polish the window with a soft, dry cloth or special optical paper to remove the thin film that may have appeared while cleaning the window.

Have a suitable measurement container filled with ultra-pure water ready nearby. Before this step, the measurement container have already been carefully cleaned with a detergent solution and rinsed with ultra-pure water.

Immerse the sensor in the container of ultra-pure water. Make sure that the measuring windows are completely covered by water. Wait 10 to 15 minutes. During this time, hidden dirt can come loose from the sensor.

Remove the probe from the water and rinse it with ultra-pure water. Empty and then refill the container with fresh ultra-pure water and immerse the sensor again. Lift the probe and move it around in the water to remove any air bubbles. Complete the function test or the calibration of the sensor.

The sensors should be positioned diagonally in the measurement container, if possible, to prevent very small, almost invisible air bubbles from collecting at the top of the measuring window. When using an upright measuring cylinder, which requires the sensor to be positioned vertically, make sure to check for air bubbles in the optical path.

Please check the stability of the container, when the sensor is immersed!

6.2 Maintenance and Inspection

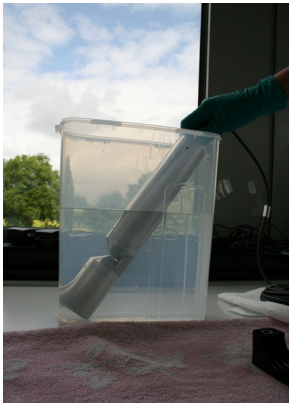
NOTICE	**Avoid touching the glass parts of the optical window, because these can become scratched or dirty. This means the functionality of the device can no longer be guaranteed.**

6.2.1 Checking the Zero Value

Prepare the sensor for the zero-value check as described in the previous chapter.

We recommend using the TriOS VALtub to check and determine the zero value, because this seals the optical path optimally and allows for a fast zero-value measurement. Make sure that the O-rings of the VALtub are positioned exactly over the seals of the sensor.

Alternatively, another container suitable for immersion can be used. When taking a measurement, the optical path must always be completely immersed in the water.



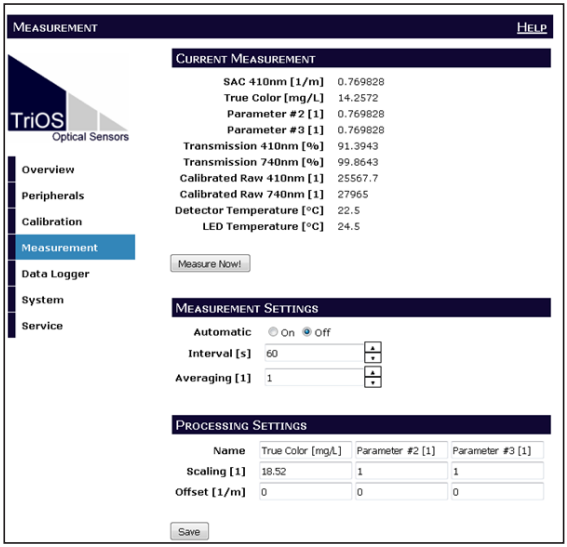
The zero value of the LISA color is checked via the web interface. To access the web interface, you will need the G2 InterfaceBox and an Ethernet-capable device with a web browser, such as a notebook / laptop.

Before the zero-value check, the sensor is prepared as described in chapter 6.1.3. Rinse the cleaned sensor carefully with deionized water and immerse it in a container of ultra-pure water. The optical path must be completely in the water. Look for air bubbles!

Do the zero-value determination at an ambient temperature of 20°C, if possible. The temperature of the ultra-pure water should also be 20°C.

General Information:

- Do not touch the part of the sensor which has been submerged in the ultra-pure water with your hands during the sensor check unless you are wearing gloves.
- Be sure to use highly pure water (ultra pure, resistance of 18.2 MΩcm) or distilled water.
- If impurities in the water show up during the check, the process must be started again!
- Make sure there are no air bubbles in front of the measuring windows. Even very small air bubbles in front of the measuring windows can cause a transmission of 97% or less.



We recommend doing at least five individual measurements in “Measurement” prior to the check to bring the sensor up to operating temperature.

The “Calibrated Raw” values for both wavelengths may not be less than 14,000 which corresponds to a light intensity of approximately 50% of the output intensity. If the “Calibrated Raw” values are less than that, make sure the measuring window is clean and the ultra-pure water is pure. If the zero-value measurement is repeatedly less than 14,000, the sensor should be sent to TriOS Mess- und Datentechnik GmbH for maintenance.

NOTICE	**Damage caused by improper cleaning is not covered by the warranty!**

SAC

If the measured value for the SAC_{xxx} in ultra-pure water is more than the value specified in the following table, clean the measuring window again and repeat the process of checking the zero value. If the zero value exceeds the limit again, first check the sensor settings and the ammeter. If the sensor settings are correct and there are no errors in the output system, the sensor should be recalibrated.

Note: An SAC_{xxx} of 1 [1/m] corresponds to an analog output of 4.53 (in a 50-mm path).

Path length [mm]	Minimum measured value SAC_{xxx} [1/m]	Minimum analog value [mA]
50	0...1	4.53
100	0...0.5	5.07
150	0...0.33	5.6
250	0...0.2	6.67

Transmission

Check the zero value with approximately 5 measured values.

- Start the measurements on the controller with an interval of 60 seconds or do about 5 individual measurements via the web interface. Document the following measured values: Transmission xxx nm and transmission 740 nm.
- If less than 90% transmission is displayed, clean the measuring window again and then carry out the zero-value check once more.
- If the display for transmission is repeatedly below 90%, recalibrate the sensor or carry out a new zero-value measurement of the sensor in ultra-pure water (see chapter 6.3.1).

Zero Value at the Analog Output

In general, the zero value of the measured value SAC_{xxx} corresponds to an analog output of 4 mA.

Zero values for transmission show a transmission value at 100%. In general, this value corresponds to an analog output of 20 mA.

In the event of a deviation of more than 10% of the transmission, which corresponds to less than 18.4 mA (display of 90% transmission) analog, first check the sensor settings and the ammeter. If the sensor settings are correct and there are no errors in the output system, the sensor should be recalibrated or a new zero-value measurement of the sensor should be carried out (see chapter 6.3.1 “Determining New Zero Point”).

Before replacing the measuring windows, the sensor must be completely and thoroughly cleaned. After replacing the measuring windows, a new zero-value measurement must be done. Detailed instructions can be found in chapter 6.3.1 “Determining New Zero Point”.

Damaged windows can be replaced by TriOS Mess- und Datentechnik GmbH customer service. Please contact TriOS customer service at support@trios.de or contact your dealer.

NOTICE **After replacing the measuring windows, carry out a new zero-value measurement.**

6.2.2 Checking the Maximum Value

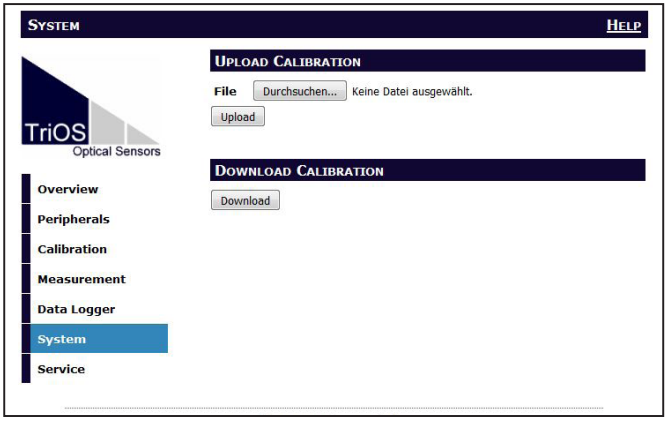
The maximum value can only be checked if the two transmission values are available.

Hold a piece of paper in the optical path so that no light can reach the detector. The following measured value shows 0% transmission. In general, this value corresponds to an analog output of 4 mA. If this value is greater than 4.5 mA (corresponding to 3% transmission), first check the sensor settings and the ammeter. If the sensor settings are correct and there are no errors in the output system, please contact TriOS Mess- und Datentechnik GmbH customer service.

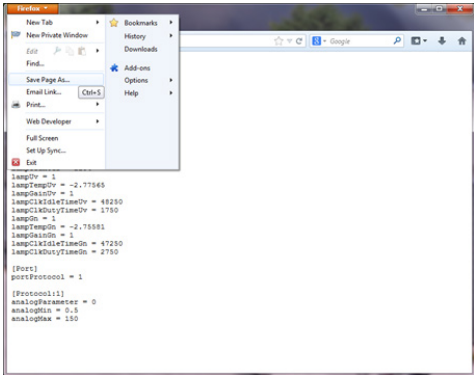
6.3 Troubleshooting

6.3.1 Determining a New Zero Point

Before you determine a new zero point, we recommend you save the current calibration so that it is recoverable at a later time.



By clicking on the “Download” button, the current calibration of the sensor can be downloaded and saved, e.g., on a PC. The LISA color presents all relevant data in the form of a calibration file, as can be seen in the example below. You should save the calibration file now and store it in a safe location.

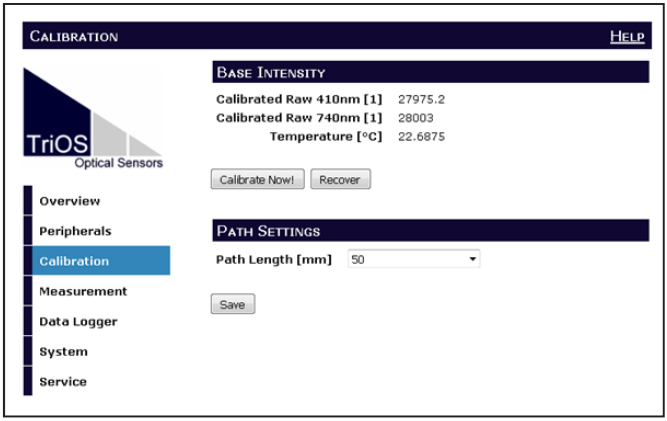


Before the actual calibration, we recommend doing 3 to 5 individual measurements in “Measurement” to bring the sensor up to operating temperature.

Carry out the zero-value determination at an ambient temperature of 20°C, if possible. The temperature of the ultra-pure water should also be 20°C.

During calibration, the base intensity I_0 for both LEDs is determined again.

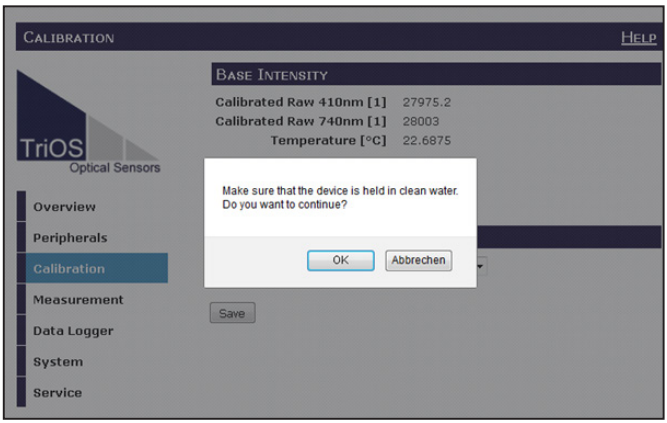
The base intensity for the zero value is delivered at 28000 +/- 500 for both LEDs. The “Calibrated Raw” values for both wavelengths may not be less than 14,000. This corresponds to a light intensity of approximately 50% of the output intensity. If the “Calibrated Raw” values are less than that, you should first make sure the measuring window is clean and the ultra-pure water is pure. If the zero-value measurement is repeatedly less than 14,000, the sensor should be sent to TriOS Mess- und Datentechnik GmbH for maintenance.



The zero value determination is done by clicking on the “Calibrate Now!” button and confirming the security query. For this procedure, the cleaned sensor must be immersed in ultra-pure water.

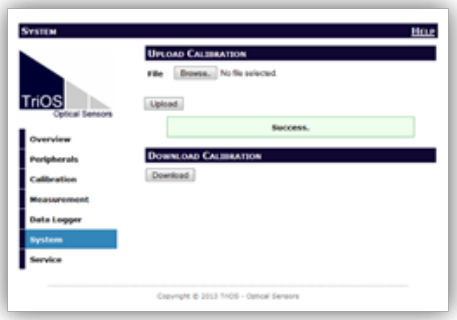
The previous zero-value measurement can be restored by clicking on “Recover”.

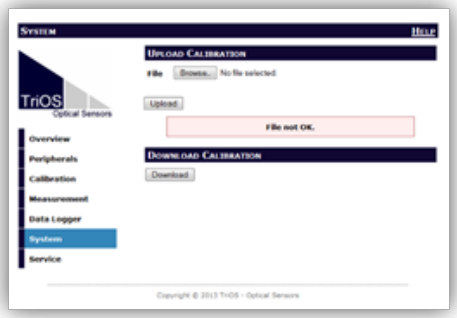
NOTICE **An incorrect zero-value measurement can result in completely false measurement results!**



The “Upload” function on the “System” page allows a previously downloaded calibration to be restored or a calibration file created by TriOS Mess- und Datentechnik GmbH service to be installed on the sensor.

Enter the storage path for the appropriate calibration file in the “File” field or select it by clicking on the “Browse...” button. Next, click on the “Upload” button to begin the transfer. When the process has been successfully completed, a green “Success” box will be displayed. If the process is not successful, a red box will be displayed with an error message as shown in the figure on the right side of the next page.



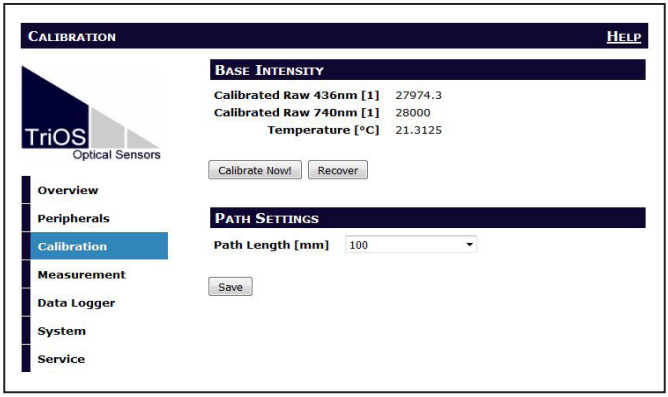


The following error messages and warnings are possible:

- **File not OK**. The calibration file could not be read correctly. Make sure that you have selected the correct file and repeat the process. If the error persists, please contact TriOS customer support at support@trios.de.
- **Device type or serial number does not match.** The calibration file is not suitable for the sensor currently connected. Make sure that the correct calibration file has been selected.

Measurements with Cuvette

As was already mentioned in chapter 4.4, measurements with a cuvette are also possible. When a cuvette is used, it is absolutely necessary to determine a zero point. Save the current zero point so that you can use the adapted calibration later during immersion operation.



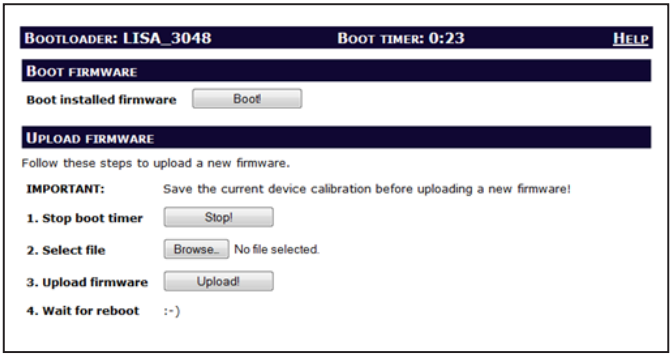
The path length is entered in the “Pathlength [mm]” combination field. Possible path lengths are 1, 2, 5, 10, 50, 100, 150 and 250 mm.

When taking measurements with a cuvette, the length of the cuvette must be set as the path length. (Only possible with 10 mm path)

Important: After the path length has been selected, it must be saved by clicking on the “Save” button for it to be used for the subsequent measurements.

6.3.2 Firmware Updates

The LISA color offers the option of updating the firmware, i.e., the operating system of the sensor with all of its functions and setting options, via the bootloader. The bootloader is shown in the following figure.



Proceed as follows to access the bootloader. First, make sure that the Ethernet adapter of your Ethernet-capable device is set as follows:

- IP: 169.254.77.2
- Subnetmask: 255.255.0.0
- no standard gateway
- no DNS server

Next, carry out the following steps:

1. Connecting the sensor to the G2 InterfaceBox. Do not switch on the power supply.
2. Connect the LAN cable to your Ethernet-capable device and the G2 InterfaceBox.
3. Switch on the power supply of G2 InterfaceBox.
4. Open the following URL in the web browser: http://lisa-color_3XXX/ (3XXX is the serial number) or http://169.254.77.2/ The boot loader will be shown.
5. Stop the “Boot timer”.
6. To load a firmware update, enter the path to the firmware file (usually named “LISA color_YYYY.MM.DD.hex”) in the “File” field or select it by clicking on the “Browse…” button. Next, click on the “Upload!” button to start the process.
7. Wait until the message “success. Please wait….” appears.
8. Reset the Ethernet adapter to automatically obtain an IP address.
9. Request the sensor again using http://lisa-color_3XXX/ or http://192.168.77.1/.
10. The usual overview page will show again.

Caution: There is a limited time period of 30 seconds to access the bootloader. If this amount of time is exceeded or if the bootloader view does not appear, remove the sensor power supply and repeat the above procedure starting at step 4.

NOTICE	**Did not switch off the sensor during the update process!**

NOTICE	**If the operating power fails during the update process a total loss of the sensor can occur.**

If the update is successful, this will be indicated by a green “Success.” box.

If an error occurs during the update process, this will be indicated by a red box with a corresponding error message.

The following is a list of possible error messages:

- **“File not found”** No firmware was found in the internal buffer memory. Attempt the update again. If the error persists, please contact TriOS Mess- und Datentechnik GmbH customer support at support@trios.de.
- **“File not OK”** An error has occurred when transferring the firmware file. Make sure that you have selected the correct file and try the update again. If the error persists, first attempt to download the update from the TriOS Mess- und Datentechnik GmbH website and carry out the update again with this file. If the problem persists, please contact TriOS Mess- und Datentechnik GmbH customer support at support@trios.de.
- **“Internal writing error”** An error has occurred while writing to the internal buffer memory. Try the update again. If the problem persists, please contact TriOS Mess- und Datentechnik GmbH customer support at support@trios.de.
- **“Firmware type does not match”** Make sure that you have selected the correct file. Is the firmware file a LISA color sensor firmware file? Does the hardware version of your sensor match the firmware file (analog or digital)?

To leave the bootloader without making changes, first reset the Ethernet adapter to “Obtain IP address automatically” and then click on the “Boot!” button. After a few seconds, the usual overview page will be displayed, and you can use the sensor.

6.4 Returns

Please follow the instructions carefully when returning items.

If you need to return the sensor, please contact customer service first. In order to ensure a smooth return process and to avoid incorrect shipments, each return must first be reported to customer service. You will then receive a numbered RMA form, which you should fill out completely and return to us. Please write the number clearly visible from outside on the return package. This is the only way your return shipment can be correctly assigned and accepted.

Caution! Return shipments without an RMA number can not be accepted and processed!

Please note that the sensor must be cleaned and disinfected before shipping. To send the goods undamaged, it is best to use the original packaging. If this is not available, make sure that a safe transport is guaranteed and that the sensors are secured by sufficient packing material.

7 Technical Data

7.1 Technical Specifications

Measurement technology	Light source	2 LEDs	
	Detector	Photodiode	
Measurement principle		Attenuation, transmission	
Optical path		50 mm, 100 mm, 150 mm, 250 mm	
Parameters		$SAC_{436,}$ $SAC_{525,}$ SAC_{620}	
		Color (based on DIN EN ISO 7887 (410 nm, 436nm, 525 nm, 620 nm)	
		Pt-Co color number (APHA/Hazen) (390 nm or 455 nm)	
		Cr-Co color number (380 nm or 413 nm)	
Measurement range		see parameter list (chapter 7.2)	
Measurement accuracy		0.5 %	
Turbidity compensation		yes, 740 nm	
Data logger		~ 2 MB	
Reaction time T100		4 s	
Measurement interval		≥ 2 s	
Housing material		Stainless steel (1.4571/1.4404) or titanium (3.7035)	
Dimensions (L x Ø)		340 mm x 48 mm (for 50-mm path)	~ 13.4” x 1.9” (for 50-mm path)
Weight	stainless steel	~ 2.4 kg (for 50-mm path)	~ 5.3 lbs (for 50-mm path)
	titanium	~ 1.3 kg (for 50-mm path)	~ 2.9 lbs (for 50-mm path)
Interface	digital	Ethernet (TCP/IP)	
		RS232 or RS485 (Modbus RTU)	
	analog	Ethernet (TCP/IP)	
		4...20 mA	
Power consumption		≤ 1 W	
Power supply		12...24 VDC (± 10 %)	
Required supervision		typically ≤ 0,5 hours per month	
Calibration/maintenance interval		24 months	
System compatibility		Modbus RTU	
		Analog out (4...20 mA)	
Warranty		1 year (EU & US: 2 years)	

INSTALLATION

Max. pressure	with Subconn	30 bars	~ 435 psig
	with fixed cable	3 bars	~ 43.5 psig
	in flow cell	1 bar, 2...4 L/min	~ 14.5 psig, 0.5 to 1 gpm
Protection type		IP68	NEMA 6P
Sample temperature		+2...+40 °C	~ +36 °F to +104 °F
Ambient temperature		+2...+40 °C	~ +36 °F to +104 °F
Storage temperature		-20...+80 °C	~ -4 °F to +176 °F
Inflow velocity		0.1...10 m/s	~ 0.33 fps to 33 fps

7.2 Measurement Ranges and Detection Limits

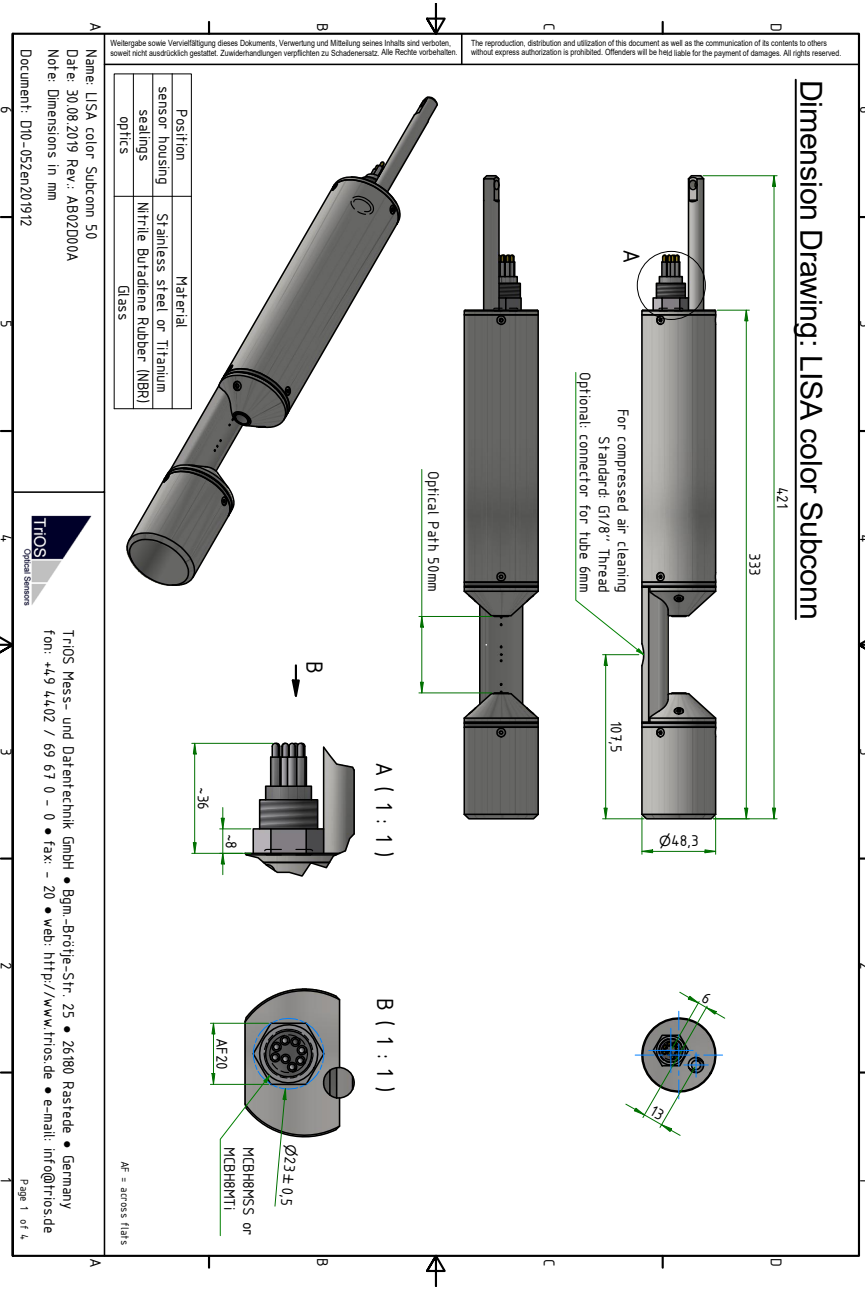
The following table provides an overview of the measurement ranges of various parameters as a function of the path length:

Parameters	Unit	Measurement range			
		50 mm	100 mm	150 mm	250 mm
SAC 436 nm	1/m	0.1...30	0.05...15	0.03...10	0.02...6
SAC 525 nm	1/m	0.1...30	0.05...15	0.03...10	0.02...6
SAC 620 nm	1/m	0.1...30	0.05...15	0.03...10	0.02...6
True color 410 nm	mg/L Pt	2...560	1...280	0.6...185	0.4...110
Hazen 390 nm	mg/L Pt	0.8...220	0.4...110	0.3...75	0.2...45
Hazen 455 nm	mg/L Pt	4...1100	2...550	1.5...360	0.8...220
Cr-Co 380 nm	° (degree of color)	1...300	0.5...150	0.3...100	0.2...60
Cr-Co 413 nm	° (degree of color)	4...1100	2...550	1.5...360	0.8...220

*under laboratory conditions

NOTICE **Transmission at 740 nm must not fall below 33%, otherwise the content of turbid substances in the medium is too high and the path must be shortened.**

7.3 External Dimensions



8 Accessories

8.1 VALtub

The VALtub is used to test and recalculate the zero values. Because of the shape, only small amounts of water are required to take a measurement.

8.2 Controllers

8.2.1 TriBox3

Digital, 4-channel display and control unit with integrated solenoid valve for compressed-air control

TriBox3 is a measurement and control system for all TriOS sensors. The device offers 4 sensor channels with selectable RS232 or RS485 function. In addition to the Modbus RTU, various other protocols are available. A built-in valve allows the use of compressed-air cleaning for the sensors. The TriBox3 also offers various interfaces, including an IEEE 802.3 Ethernet interface, an IEEE 802.11 b/g/n interface, a USB connection and 6 analog outputs (4...20 mA). An integrated relay can be used to trigger alarms or to control external devices. Features such as low power consumption, a robust aluminium housing and a range of interfaces make it suitable for all applications associated with environmental monitoring, drinking water, wastewater treatment plants and many other areas.

8.2.2 TriBox Mini

Digital 2-channel controller

Mini controller with two digital sensor inputs and two 4...20mA outputs. All of the measured values and diagnostics data that is stored can be selected using an integrated web browser.

8.3 Compressed air fittings for 100-250 mm paths

9 Warranty

The warranty period of the devices within the EU is 2 years from the date of the invoice. Outside of the EU, the warranty period is one year. All normal consumables, such as light sources, are not included in the warranty.

The warranty is subject to the following conditions:

- The device and all accessories must be installed as described in the corresponding manual and must be operated according to the specifications.
- Damage due to contact with corrosive and damaging substances, liquids or gases and damage during transport are not covered by the warranty.
- Damage due to improper handling and use of the device is not covered by the warranty.
- Damage resulting from modification or unprofessional attachment of accessories by the customer is not covered by the warranty.

NOTICE	**Opening the sensor voids the warranty!**

10 Customer Service

If you are having a problem with the sensor, please contact the TriOS customer service.

We recommend sending the sensor in for maintenance and calibration every 2 years. To do this, please request an RMA number from customer service.

Technical support contacts:

support@trios.de

Tel.: +49 (0) 4402 69670 - 0

Fax: +49 (0) 4402 69670 – 20

To help us provide you faster service, please send us the sensor ID number by email (the last four digits of the serial number consisting of letters and numbers, e.g., 28B2).

11 Contact

We are constantly working to improve the devices. Visit our website for news.

If you have found an error or bug in one of the devices or programs, please let us know:

Customer service:	support@trios.de
General questions / sales:	sales@trios.de
Website:	www.trios.de

TriOS Mess- und Datentechnik GmbH

Bürgermeister-Brötje-Str. 25

D-26180 Rastede

Germany

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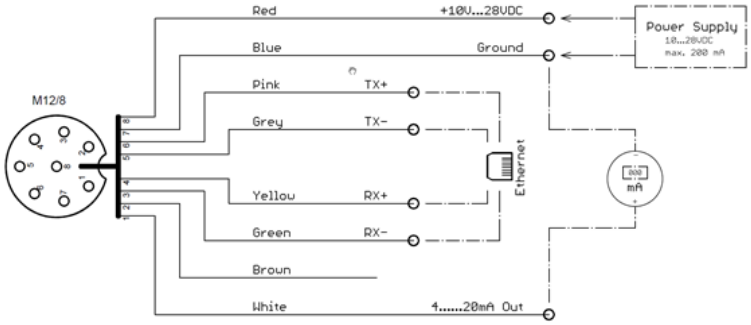
Fax	+49 (0) 4402 69670 - 20

12 Keyword Index

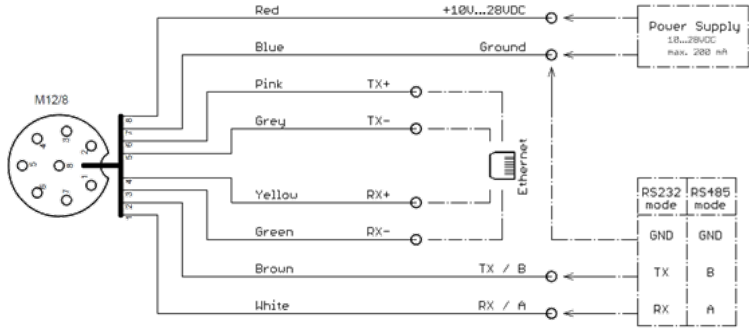
13 FAQ - Frequently Asked Questions

You can find more FAQs on the website: **www.trios.de**.

1. What is the cable configuration of the M12 plug for the analog version of the LISA color:



2. What is the cable configuration of the M12 plug for the digital version of the LISA color:



3. When do I need the G2 InterfaceBox?

   The LISA color is an innovative measurement instrument that can be operated without additional hardware.

   The G2 InterfaceBox is used to change sensor-specific settings. It can be connected between an Ethernet-capable device and the LISA color and allows access to all settings via a web browser.

   For more information, please refer to chapter 3.2.3 of this manual.

4. What wavelengths are used to take measurements?

The LISA color measures at two different wavelengths: xxx nm (depending on the version ordered) and 740 nm (red). The measurement at 740 nm is intended as a turbidity correction for the SAC_{xxx} value. The transmission is measured at xxx nm without correction. These wavelengths are fixed and cannot be changed.

5. Why do the optical windows have to be cleaned carefully?

The windows of an optical measurement device must always guarantee maximum transmission. Scratched or cracked windows can significantly affect the measurement and can result in bad measurements.

Annex

CE Declaration of Conformity

Hersteller/Manufacturer/Fabricant: TriOS Mess- und Datentechnik GmbH
Bürgermeister-Brötje-Str. 25
D- 26180 Rastede

Konformitätserklärung
Declaration of Conformity
Déclaration de Conformité

Die TriOS GmbH bescheinigt die Konformität für das Produkt
The TriOS GmbH herewith declares conformity of the product
TriOS GmbH déclare la conformité du produit

Bezeichnung Product name Designation	**LISA**
Typ / Type / Type:	**color**
Mit den folgenden Bestimmungen With applicable regulations Avec les directives suivantes	2014/30/EU EMV-Richtlinie 2011/65/EU RoHS-Richtlinie
Angewendete harmonisierte Normen Harmonized standards applied Normes harmonisées utilisées	EN 61326-1:2013 EN 55011:2009 + A1:2010 EN 61010-1:2010 EN 50581:2012
Datum / Date / Date 27.01.2017	Unterschrift / Signature / Signatur R. Heuermann

D05-052yy201701

Modbus RTU

Serial Interface

Upon delivery, the LISA color is configured to RS485 with the following settings:

- Baud rate: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity: none

Data types

Name	Register	Format
Bool	1	False: 0x0000, True: 0xFF00
Uint8	1	Unsigned 8 bit integer. Range: 0x0000 - 0x00FF
Uint16	1	Unsigned 16 bit integer. Range: 0x0000 - 0xFFFF
Uint32	2	Unsigned 32 bit integer. Range: 0x00000000 - 0xFFFFFFFF
Float	2	IEEE 754 32 bit floating point value
Char[n]	$\left[\frac{n}{2}\right]$	Null-terminated ASCII character string

Functions

The LISA color supports the following Modbus functions:

Name	Code	Description / Use
Read multiple registers	0x03	Read the serial number, configuration, calibration and measurement data
Write multiple registers	0x10	Write the configuration and calibration
Write single coil	0x05	Trigger the calibration and measurement
Write single register	0x06	Trigger the calibration and measurement
Report slave ID	0x11	Read the serial number

Standard Modbus server address

Upon delivery, the LISA color is set to address 2 (0x02).

Read / Write multiple registers (0x03 / 0x10)

The following values are in the registers:

Designation	R/W	Address	Data type	Description
LISA color serial number	R	10	Char[10]	Serial number of the LISA color sensor
Lamp serial number	R	20	Char[44]	Serial number followed by the type designation followed by the shot counter (see below) of the LISA color lamp module
Self-trigger	RW	100	Bool	Indicates whether the sensor is in automatic mode
Averaging	RW	101	Uint16	Number of individual measurements which are averaged for a measurement
Interval	RW	102	Uint32	The measurement interval in [s] for the automatic mode
Offset Parameter #1	RW	104	Float	Offset for the calculation of the first parameter derived from the SAC. Formula: y = scaling x (SAC – offset)
Scaling Parameter #1	RW	106	Float	Scaling factor for the calculation of the first parameter derived from the SAC. Formula: y = scaling x (SAC – offset)
Offset Parameter #2	RW	108	Float	Offset for the calculation of the second parameter derived from the SAC. Formula: y = scaling x (SAC – offset)
Scaling Parameter #2	RW	110	Float	Scaling factor for the calculation of the second parameter derived from the SAC. Formula: y = scaling x (SAC – offset)
Offset Parameter #3	RW	112	Float	Offset for the calculation of the third parameter derived from the SAC. Formula: y = scaling x (SAC – offset)
Scaling Parameter #3	RW	114	Float	Scaling factor for the calculation of the third parameter derived from the SAC. Formula: y = scaling x (SAC – offset)
Shot Counter	R	200	Uint32	The number of measurements that the lamp has taken over the duration of its life
SAC	R	1000	Float	Spectral absorption coefficient for in [1/m] (corrected for turbidity)
Parameter #1	R	1002	Float	First parameter derived from SAC (generally specified at the factory)
Parameter #2	R	1004	Float	Second parameter derived from SAC
Parameter #3	R	1006	Float	Third parameter derived from SAC
Transmission Color	R	1008	Float	Transmission of the color LED in [%]
Transmission Correction	R	1010	Float	Transmission of the correction LED in [%]

Write single coil / register (0x05 / 0x06)

Writing a value not equal to false (0x0000) into a coil / register of the following address triggers the corresponding action listed below.

Designation	Address	Description
Start Measurement	1	Defines a measurement command in the command queue

Report slave ID (0x11)

Provides the sensor designation followed by the serial number followed by the firmware version each as a null-terminated ASCII character string.

Example:

L	I	S	A	-	C	O	L	O	R	0x00	3	8	4	4	0x00	1	.	0	0x00