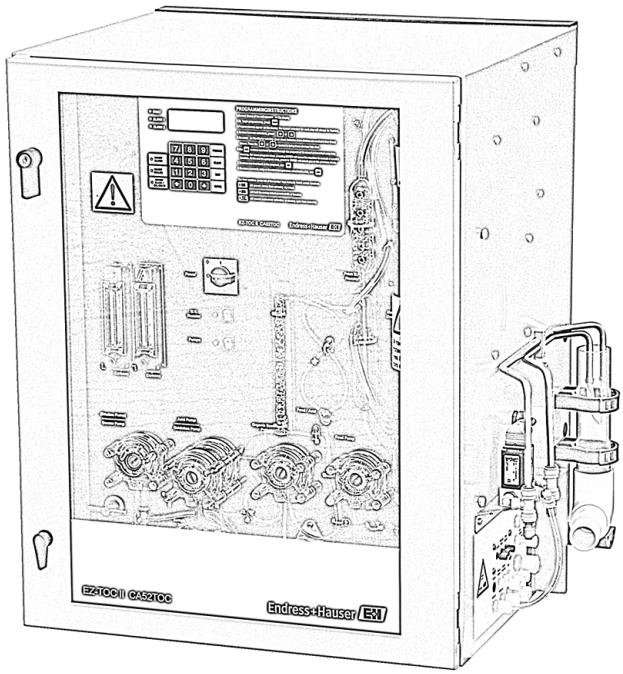
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

EZ-TOC II analyzer CA52TOC

Analyzer for continuous real-time TOC measurement in water and wastewater



BA424C/07/en/06.09
71085882

Endress+Hauser

People for Process Automation

Table of contents

1 Safety instructions

1.1 Designated use

CA52TOC is an analyzer for continuous real-time TOC measurement in water and wastewater.

The analyzer is particularly suitable for use in the following areas:
- Monitoring of organic carbon in water and wastewater
- Industrial processes
- Outlet monitoring in sewage treatment plants
- Monitoring of spring water and drinking water
- Control of methanol dosage

Any other use than the one described here compromises the safety of persons and the entire measuring system and is not permitted.
The manufacturer is not liable for damage caused by improper or non-designated use.

1.2 Installation, commissioning and operation

Please note the following items:
- Installation, commissioning, operation and maintenance of the measuring system must only be carried out by trained technical personnel.
  Trained personnel must be authorized for the specified activities by the system operator.
- Electrical connection must only be carried out by a certified electrician.
- Technical personnel must have read and understood these Operating Instructions and must adhere to them.
- Before commissioning the entire measuring point, check all the connections. Ensure that electrical cables and hose connections are not damaged.
- Do not operate damaged products and secure them against unintentional commissioning. Mark the damaged product as being defective.
- Measuring point faults may only be rectified by authorized and specially trained personnel.
- If faults can not be rectified, the products must be taken out of service and secured against unintentional commissioning.
- Repairs not described in these Operating Instructions may only be carried out at the manufacturer's or by the service organization.

1.3 Operational safety

The analyzer has been designed and tested to the highest standards and left the factory in perfect functioning order.
Relevant regulations and European standards have been met.

As the user, you are responsible for complying with the following safety conditions:
- Installation instructions
- Local prevailing standards and regulations.

Immunity to interference
This instrument has been tested for electromagnetic compatibility in industrial use according to applicable European standards.
Protection against interference as specified above is valid only for an instrument connected according to the instructions in these Operating Instructions.

1.4 Return

If the analyzer has to be repaired, please contact the responsible sales center.
If the analyzer has to be returned, please return it *cleaned* to the responsible sales center.
Please use the original packaging, if possible.

Please enclose the completed "Declaration of contamination" (copy the second last page of these Operating Instructions) with the packaging and the transportation documents.
No repair without completed "Declaration of contamination"!

1.5 Notes on safety icons and symbols

Warning!
This symbol alerts you to hazards that can cause serious damage to the instrument or to persons if ignored.

Caution!
This symbol alerts you to possible faults which could arise from incorrect operation. They could cause damage to the instrument if ignored.

Note!
This symbol indicates important items of information.

Electrical symbols

Direct Current (DC)
A terminal at which DC is applied or through which DC flows.

Alternating Current (AC)
A terminal at which (sine-form) AC is applied or through which AC flows.

Ground connecting
A terminal which, from the user's point of view, is already grounded using a grounding system.

Protective ground terminal
A terminal which must be grounded before other connections may be set up.

Alarm relay

Input

Output

DC voltage source

Temperature sensor

2 Identification

2.1 Nameplate

Please check the order code from the nameplate with the product structure and with your order.

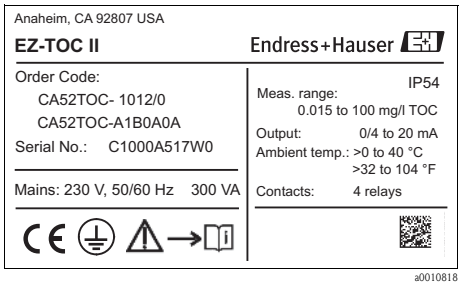


Fig. 1: Nameplate (example)

2.1.1 Product structure

	Measuring range							
	A	0.015 to 10 mg/l TOC						
	B	0.1 to 100 mg/l TOC (not with CA52TOC-**C****)						
	C	0.5 to 500 mg/l TOC (not with CA52TOC-**C****)						
	D	10 to 1000 mg/l TOC (not with CA52TOC-**C****)						
	E	50 to 5000 mg/l TOC (not with CA52TOC-**C****)						
	F	100 to 10000 mg/l TOC (not with CA52TOC-**C****)						
	Y	Special version according to customer specification						
		Sample transfer						
		1	1 measuring point (not with CA52TOC-****D**; CA52TOC-****E**)					
		2	2 measuring points					
			TIC removal					
			A	Standard				
			B	High				
			C	Ultra high (only with CA52TOC-A******)				
			Y	Special version according to customer specification				
				Power supply				
				0	230 VAC, 50/60 Hz			
				1	115 VAC, 50/60 Hz			
					Sample preparation			
					A	Not selected		
					B	1 x PA-2 PVC, 1 to 8 m^3/h (4.4 to 35 gpm) wastewater		
					C	1 x PA-3 PVC, 0.1 to 1.0 m^3/h (0.4 to 4.4 gpm) wastewater		
					D	2 x PA-2 PVC, 1 to 8 m^3/h (4.4 to 35 gpm) wastewater (not with CA52TOC-*1*****)		
					E	2 x PA-3 PVC, 0.1 to 1.0 m^3/h (0.4 to 4.4 gpm) wastewater (not with CA52TOC-*1*****)		
					Y	Special version according to customer specification		
						Carrier gas		
						0	To order separately	
						1	CO_2 scrubber	
						2	CO_2 scrubber + compressor	
						9	Special version according to customer specification	
							Output	
							A	0/4 to 20 mA + RS 232 unidirectional
CA52TOC-								**Complete order code**

2.2 Scope of delivery

The scope of delivery comprises:
- 1 EZ-TOC II analyzer CA52TOC
- 1 set of tubing (4 pieces)
- 1 set of fittings (17 pieces)
- 2 bottles (5.5 US gal)
- 3 bottles (2 US gal)
- 5 bottle caps (with hole for tube)
- Operating Instructions, English
- 1 Allen key
- 1 drain plug with gasket
- 1 special key for peristaltic pump
- 1 key for door lock

If you have any questions, please contact your supplier or your local sales center.

2.3 Certificates and approvals

Declaration of conformity
The product meets the requirements of the harmonized European standards. It thus complies with the legal requirements of the EC directives.
The manufacturer confirms successful testing of the product by affixing the CE symbol.

3 Installation

3.1 Incoming acceptance, transport, storage

- Make sure the packaging is undamaged!
  Inform the supplier about any damage to the packaging.
  Keep the damaged packaging until the matter has been settled.
- Make sure the contents are undamaged!
  Inform the supplier about damage to the contents. Keep the damaged products until the matter has been settled.
- Check that the order is complete and agrees with your shipping documents.
- The packaging material used to store or to transport the product must provide shock protection and humidity protection. The original packaging offers the best protection. Also, keep to the approved ambient conditions (see "Technical data").
- If you have any questions, please contact your supplier or your local sales center.

3.2 Installation conditions

3.2.1 Location

The analyzer can be installed in two ways:
- standalone on a table
- mounted on a wall

The analyzer requires a gravity drain which is vented to the atmosphere.
If located inside a building, a vent is required. The accumulation of halogens or other vapors is not permitted in this area.

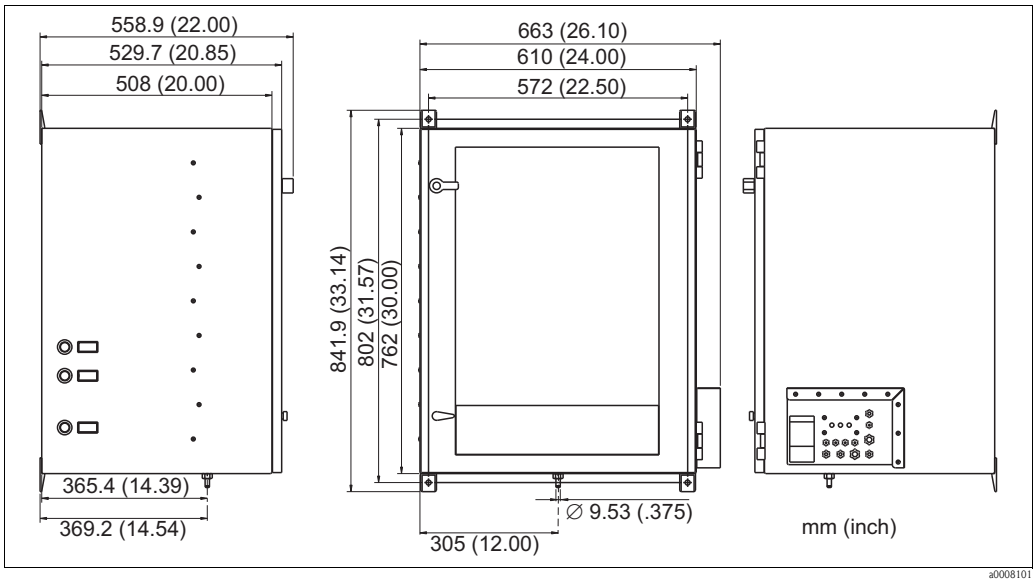


Fig. 2: Dimensions

3.2.2 Compressed air supply

The compressed air (used as a carrier gas) must be dry and must meet the following specifications:

- < 3 ppm CO_2
- < 3 ppm hydrocarbon
- Constant pressure 2 bar (29 psi).
- Consumption 500 to 750 cm^3/min
- The in-house compressed air supply must be equipped with a CO_2 scrubber (input pressure 4.0 to 10 bar (58 to 145 psi)) and a pressure reducing valve.

Bottled air, nitrogen or oxygen can also be used as a carrier gas.

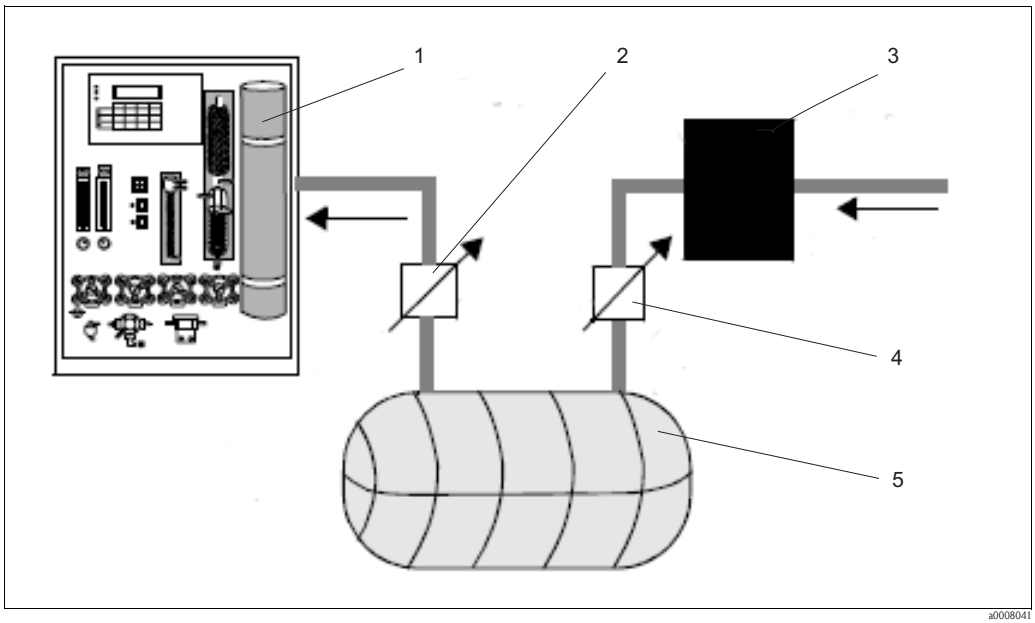


Fig. 3: Measuring system when air supply is unstable

1 EZ-TOC II analyzer CA52TOC
2 Pressure regulator
3 CO_2 scrubber
4 Pressure regulator
5 Air reservoir > 5 l (> 1.3 US gal)

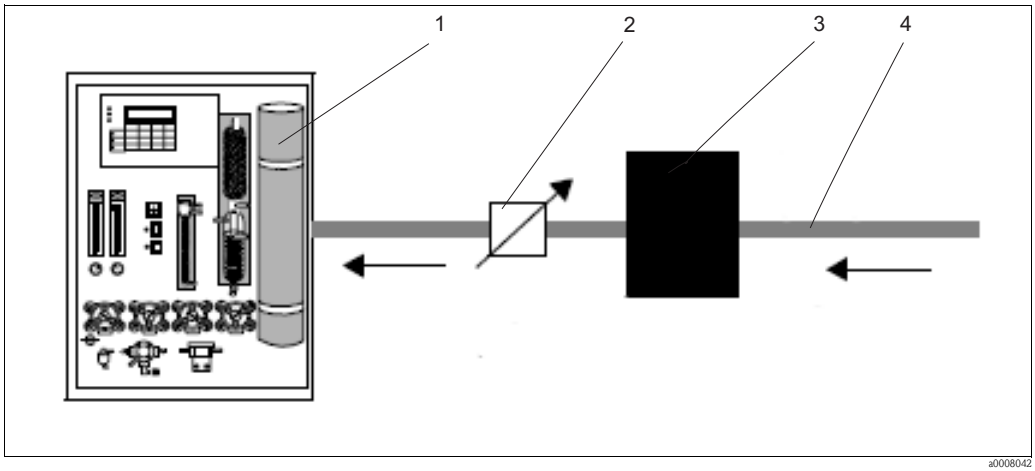


Fig. 4: Measuring system when air supply is stable

1 EZ-TOC II analyzer CA52TOC
2 Pressure regulator
3 CO_2 scrubber
4 Stable air supply (or bottle) > 6 bar (> 87 psi)

3.3 Installation instructions

3.3.1 Mounting

The analyzer has four mounting holes in the back of the cabinet. Use at least 10 mm (5/16") mounting hardware to support the unit, as it is heavy. The mounting feet on the back of the analyzer provide clearance between the wall and the cabinet.

3.3.2 Installing the UV lamp

Caution!
The UV lamp is extremely fragile. Perform installation with care.

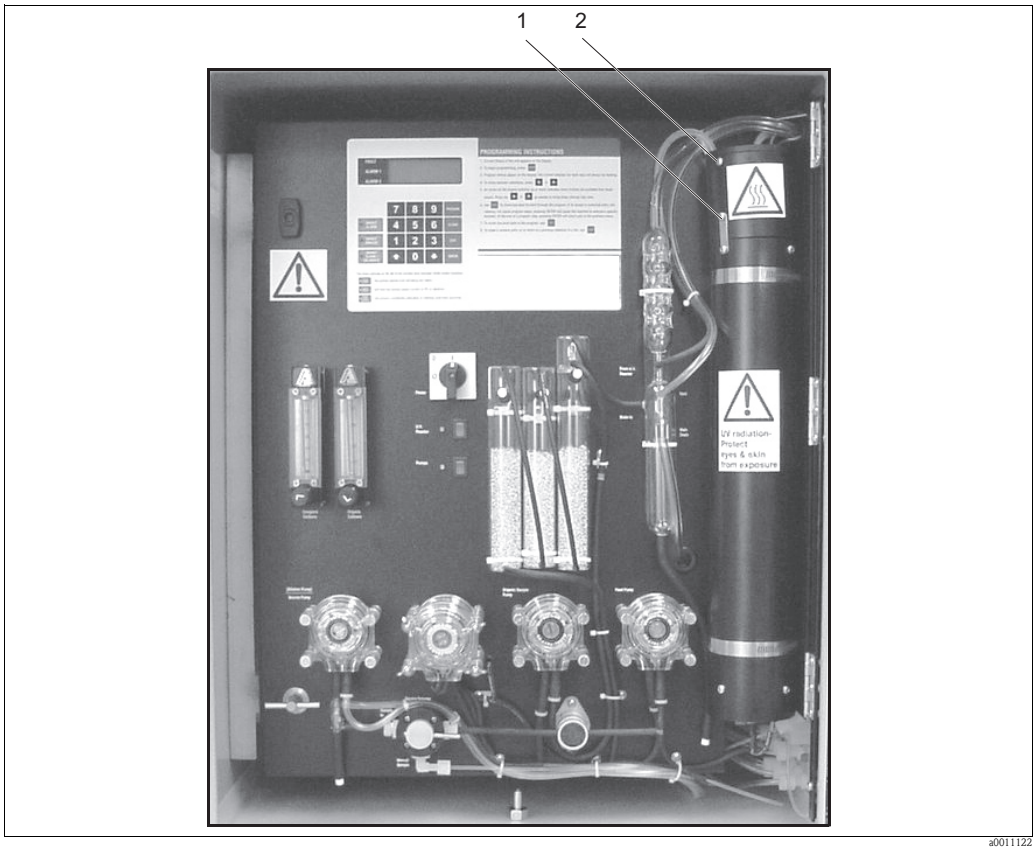


Fig. 5: UV reactor

Preparation

1. Open the cabinet door and swing out the analyzer's front panel. Block the door and panel, so that they will not swing back.
2. Remove the top Phillips screw on the reactor ground strap (pos. 1, Fig. 5).
3. Remove the Phillips screw above the ground strap (pos. 2, Fig. 5).
4. Remove the reactor cap.
5. Remove the top of the reactor shell.

Installing the lamp

1. Inside the reactor, remove the reactor nut and the two O-rings beneath it.
2. Carefully slide first the reactor nut, then the two O-rings, over the glass end of the UV lamp to the top of the lamp.
3. Insert the lamp into the center of the reactor. Exert a gentle downward pressure on the lamp as you tighten the reactor nut. The lamp's metal sleeve must be against the nut.
4. ☝ Caution!
   Tighten with care.
   Undertightening the reactor nut can result in leakage, causing damage to the analyzer.
   Overtightening the reactor nut can break the outer casing of the UV lamp.

   Hand-tighten the reactor nut, and then tighten it by one additional half turn.
5. Replace the top, cap and ground strap on the reactor shell.

3.3.3 Connecting the gas sources

Gas and liquid connections are all made via the connection panel located in the lower right-hand side of the cabinet.

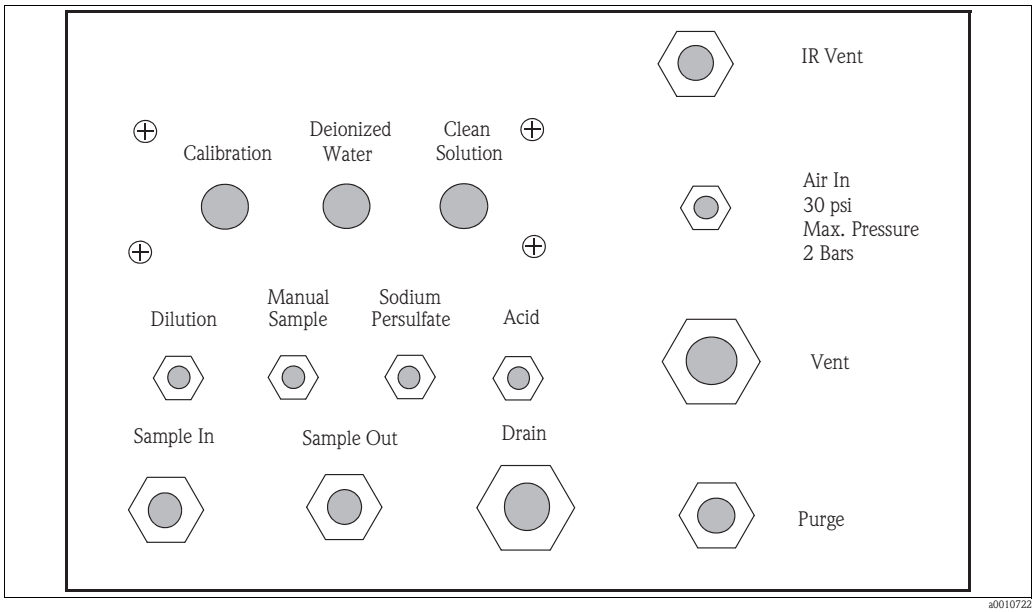


Fig. 6: Connection panel for gas and liquid connections

All connections are made using PFA or Kynar® fittings. Tighten the fittings securely, but be careful to avoid overtightening the fittings, as you may destroy the threads.

3.3.4 Connecting the medium

Connecting the air supply:

1. Use PFA tubing to attach the air supply line to the "Air In" fitting.
2. Tighten the fittings securely.

Caution!
Do not under any circumstances allow the air pressure entering the analyzer to exceed 2 bar (30 psi) maximum, as this could damage the analyzer and result in personal injury.

3. Turn on the air supply.
4. Use a mixture of water and soap to check for leaks. Paint the mixture directly onto the connections at the analyzer and the air supply. If there is a leak, bubbles will form around the connection. Tighten the fitting a little more and recheck the connection. Do not overtighten the fittings or you may destroy the threads.

Connection of the liquid medium:

1. Place the medium bottles close to the analyzer.
2. Pour the reagents (acid, persulfate) into the two 5.5 US gal bottles. Pour the cleaning, calibration and DI solutions into the three 2 US gal bottles. Use the bottle caps with a hole (included in the delivery) during operation of the analyzer. Use the bottle caps without a hole for transport and storage.
3. Cut five pieces of 1/8" PFA tubing long enough to reach the bottom of the medium bottles and the medium connections of the connection panel.
4. Pass the ends of the tubes through the holes in the bottle caps to the bottom of the bottles.
5. Connect the other ends of the tubes to the corresponding fittings on the connection panel.

3.3.5 Preparing chemicals

Warning!
Accidents with chemicals can kill, blind, burn, or damage lungs. Many chemicals are poisonous or corrosive; some are explosive, by themselves or in combination. Others are hazardous because they can be absorbed easily through skin or the respiratory system. When working with any chemicals, always observe the precautions in the section "Precautions regarding use of chemicals".

Precautions regarding use of chemicals

- Read the material safety data sheets (MSDS) provided with each chemical to see what hazards are present and what precautions you must take. If you are not sure of the risks, seek assistance from qualified individuals.
- Never prepare chemicals by yourself. If an accident happens, you may need help. Make sure someone else is nearby. Prepare chemicals only in a properly-equipped lab facility.
- Always wear goggles, rubber gloves and a rubber apron when preparing chemicals. If you work with finely powdered chemicals, wear a protective face mask or respirator.
- Never breathe, taste, or swallow any chemical or solution used with the EZ-TOC II analyzer (or any other process analytical device).
- When solutions are prepared, always label containers with contents and date of preparation. Dispose of unlabeled or expired solutions in accordance with local regulations.
- Some chemicals react violently when combined or dissolved in water, causing explosions, fire, heat, or the dangerous discharge of gases, foam or spray. Avoid the risk of a serious accident; if you do not know how certain chemicals will react, do not combine them. Never combine chemicals known to react very strongly.

There are three chemical solutions normally used with the EZ-TOC II. They are:

- Phosphoric acid, H_3PO_4, 10% (v/v) solution
  It is used to acidify the sample solution. This transforms carbonate ion ($CO_3^=$) to CO_2 and eliminates dissolved CO_2 from the solution.
- Potassium Hydrogen Phthalate (KHP) 1–10,000 mg/l
  This is the standard solution used to calibrate the analyzer. Other chemicals can be used.
- Sodium Persulfate, $Na_2S_2O_8$, 1.5 M
  (Note that this chemical is also called sodium peroxidisulfate.) It is used with UV light in the analyzer to oxidize the organic carbon in the sample.

Reagent quality

Note!
Reagent quality can affect the accuracy of measurements. For this reason, follow the steps outlined below to ensure reagent quality.

- For 10, 100, and 500 mg/l units, use the best grade of reagents. For 1,000, 5,000, and 10,000 mg/l units, ordinary commercial grade acids and persulfate are suitable. For the KHP calibration standard, use reagent grade or better for all units. For the 1,000, 5,000 and 10,000 mg/l units, you can experiment with quality once you have established repeatability, and as long as the results are not affected. Lower grades of acid and persulfate may be acceptable.
- Rinse all glassware and plastic containers thoroughly with deionized water. For best results, acid-wash and rinse them again before use.
- Use good scales and weigh the standard as accurately as possible before mixing. Keep containers closed to prevent contamination and deterioration.
- Accurate preparation of the calibration standard is essential for accurate calibration of the analyzer. Inaccurate preparation of the standard will result in an erroneous calibration, which in turn will yield worthless results.
- The KHP calibration standards for 10 and 100 mg/l deteriorate rapidly in solution. Keep containers closed when not in use, and store in a cool place (such as a refrigerator). Heat and exposure to air can ruin sensitive solutions quickly.

Preparation of phosphoric acid

Caution!
Phosphoric acid can cause blindness and burns to the skin. Always add acids to water; never the reverse. Wear goggles, gloves, and a rubber apron.

Shelf life: Indefinite, 10% (v/v) solution.

Procedure:

For 2 l (0.53 US gal)	Mix 200 ml (6.75 fl.oz) of concentrated phosphoric acid (85%) with 1,800 ml (0.48 US gal) of deionized (DI) water. This will yield 2 l of 10% (v/v) acid.
For 1 l (0.264 US gal)	Mix 100 ml (3.38 fl.oz) of concentrated phosphoric acid (85%) with 900 ml 0.237 US gal) of deionized water.
For 20 l (5.5 US gal)	Mix 2 l (0.53 US gal) of concentrated phosphoric acid (85%) with 18 l (4.75 US gal) of deionized water.

Preparation of sodium persulfate

Caution!
Sodium persulfate is a strong oxidizing agent. It can cause burns to your skin and damage to the respiratory system. It can also start fires when mixed with combustible materials. Do not breathe the dust or ingest the prepared solution. This solution is very strong (1.5 M); do not spill it on your skin or clothing. It may bleach out colors or attack certain fabrics.

Note!
This reagent needs to age; prepare it 24 hours before you need to use it. Label the container with the name of the contents and the date of preparation.

Shelf life: 4 to 6 weeks; 1.5 molar

Procedure:

For 2 l (0.53 US gal)	Add deionized water to 700 g (24.6 oz) of sodium persulfate to a total of 2 liters and mix.
For 1 l (0.264 US gal)	Add deionized water to 350 g (12.3 oz) of sodium persulfate to a total of 1 liter and mix.
For 20 l (5.5 US gal)	Mix 7 kg (15.4 lbs) to 10 l (2.64 US gal) of deionized water to dissolve the persulfate, then add enough water to make 20 l (5.28 US gal) of solution.

Note that when you mix this solution there will be an endothermic reaction (the bottle will become cold). At 25° C (77° F), the maximum solubility of sodium persulfate in water is 425 g (15 oz) per l. As temperature decreases, so does solubility. 700 g (24.6 oz) in 2 l (0.53 US gal) of water will take the same time to dissolve and at this concentration should not recrystallize inside the unit.

Preparation of potassium hydrogen phthalate

Caution!
Potassium Hydrogen Phthalate (KHP) can cause eye and skin irritation, and respiratory problems. Do not breathe the dust or ingest the prepared solution.

Shelf life: Relatively stable, depending on concentration. (Stability decreases with decreasing concentration; refrigeration is suggested.)

Concentrations: Application-dependent.

Procedure:
For a 10,000 mg/l organic carbon solution, dissolve 21.254 grams of reagent grade (or better) KHP in 500-700 ml of deionized water in a one-liter volumetric flask (refer to the following table for other concentrations of solution). After the chemical is dissolved, add water to bring the total volume to one liter. Remix the solution. Label the container with the name of the contents and the date of preparation.

mg/l Carbon	g KHP	Volume
10,000	21.254	1 l
1,000	2.1254	1 l
500	1.0627	1 l
100	0.21254	1 l
10	0.021254	1 l

The 10,000 mg/l solution is stable (especially if refrigerated). It is suggested that **serial dilutions** be made from a 10,000 mg/l standard to lower concentrations as needed. For example:

- 10 ml of 10,000 mg/l solution diluted with 90 ml deionized water yields a 1,000 mg/l solution.
- 10 ml of 1,000 mg/l solution diluted with 90 ml deionized water yields a 100 mg/l solution.
- 10 ml of 100 mg/l solution diluted with 90 ml deionized water yields a 10 mg/l solution.

The **serial** dilution is preferred for making the lower concentrations rather than taking 1 ml from the 10,000 mg/l solution and diluting it with 99 ml of deionized water. Using this latter method could introduce an error in measurement.
Note that while stock standards of 1,000 and 10,000 mg/l are fairly stable at room temperature for several weeks, 10 mg/l solutions will begin to degrade at room temperature within **3 to 5 days**. Note also that you should keep the container of the crystalline KHP closed. Left open to the atmosphere, it will readily absorb water and have to be dried prior to use. Otherwise, your measurements will be inaccurate, due to the lower concentrations of carbon in the hydrated salt. Dry exposed KHP at 105 °C (221 °F) for one hour.

Use of other acids

Generally phosphoric acid is the acid recommended for use in the analyzer. The reasons for this are as follows:

- It is a strong enough acid that very little is needed to reduce the stream pH to 2.0.
- It usually has very little organic content of its own.

Phosphoric acid is not recommended if the sample stream contains high concentrations of Group II (alkaline earth) metal ions, specifically calcium (Ca^{++}) or magnesium (Mg^{++}) or both. These ions will form insoluble phosphates. These precipitates could plug the TIC scrubber and the U-tube drain. Enough deposits can ruin the glassware. Use a different inorganic acid such as 5% Nitric (HNO_3).

Caution!
Nitric acid is a poison and a strongly corrosive acid capable of causing serious skin burns and blindness. Reactions with metals or other chemicals can release toxic, irritating fumes (oxides of nitrogen). Nitric acid is a strong oxidizing agent that can produce dangerously unstable byproducts. Note that nitric acid is used in the production of many explosives.

If you must use other acids, prepare the dilutions with care:
- Always follow good laboratory procedures.
- Use a vented hood to exhaust any fumes that could evolve from the preparation.
- **Always add acid to water**.
- Avoid any spillage or skin contact and never work with the concentrated acids by yourself.

Use of other chemicals for TIC standards

For TIC (Total Inorganic Carbon), the most commonly used standard is **sodium carbonate, Na_2CO_3**.

Prepare solutions as follows:
- 1,000 mg/l
  Add **8.833 g** of Na_2CO_3 to a 1 l volumetric flask, then fill with deionized water.
- 10,000 mg/l
  Add **88.33 g** of Na_2CO_3 to a 1 l volumetric flask, then fill with deionized water.

Serial dilutions can be made as described previously for the KHP standard.

You can also use **potassium carbonate, K_2CO_3** for the TIC standard.

Prepare solutions as follows:
- 1,000 mg/l
  Add **11.517 g** of K_2CO_3 to a 1 l volumetric flask, then fill with deionized water.
- 10,000 mg/l
  Add **115.17 g** of $K_2CO_3$to a 1 l volumetric flask, then fill with deionized water.

Both Na_2CO_3 and K_2CO_3 standards are stable at room temperature for up to two weeks if the deionized water is above pH 7. Keep the containers closed to delay the eventual transformation of the carbonate into bicarbonate salt.

Use of other chemicals for TOC standards

Other carbon-containing chemicals have been used for TOC standards for various reasons. For the purpose of consistency, these compounds must be **nonvolatile** and have carbon that can be made to react effectively enough in the analyzer. Some examples are ethylene glycol, benzoic acid and sucrose.
The amounts given below are to prepare one liter of 1,000 mg/l solution. Other solutions can be made by using the serial dilution method described previously for KHP or by increasing the quantity tenfold to make a 10,000 mg/l concentration.
Ethylene Glycol - ($C_2H_4(OH)_2$) This is readily available from supply houses and oxidizes easily in the analyzer. It is easy to handle and is infinitely soluble in water. However, you must keep the container tightly closed, as the substance rapidly absorbs water when exposed to air, and displays no obvious physical change when it has been diluted.
To make a 1,000 mg/l solution, add 2.586 grams to a 1 liter volumetric flask, then fill with deionized water.
Benzoic Acid - ($C_6H_5CO_2H$) To make a 1,000 mg/l solution, add 1.454 grams to a 1 liter volumetric flask, then fill with deionized water. This agent is chemically similar to phthalic acid, from which KHP is made.
Sucrose - ($C_{12}H_{22}O_{11}$) Sucrose is not usually recommended, but is sometimes used when other standards are not readily available. Common table sugar can be used as a fair approximation in an emergency. For a 1,000 mg/l solution, add 2.377 grams to a 1 liter volumetric flask, then fill with deionized water.

Chemicals not recommended for standards

The following chemicals are **not** recommended for use as standards in the analyzer. They are not suitable for various reasons. They may not be soluble in water, or their boiling point may be too low. If the boiling point is too low, the solution will separate in the reactor and you will be unable to establish an accurate standard.
Methanol - (CH_3OH) Also called methyl alcohol or wood alcohol. Boiling point is 65 °C (149 °F).
Ethanol - (C_2H_5OH) Also called ethyl alcohol or grain alcohol. Boiling point is 78 °C (172 °F).
Acetone - (CH_3COCH_3) Also called dimethyl ketone, 2-Propanone. Boiling point is 56 °C (133 °F).
MEK - ($CH_3CH_2COCH_2$) Also called methyl ethyl ketone, 2-Butanone. Boiling point is 80 °C (176 °F).
Carbon Tetrachloride - (CCl_4) Boiling point is 76 °C (169 °F), CCl_4 is toxic, and is essentially insoluble in water.
Compounds that oxidize with difficulty in the UV-persulfate process, should be avoided. An example of this would be oxalic acid ($H_2C_2O_4$) or urea (NH_2CONH_2).

Cleaning solutions

Cleaning solutions for the analyzer are usually dependent on the particular site application for their effectiveness. Consequently, only general recommendations can be made about the composition of the cleaning agents.

Warning!
Cleaning solutions for laboratory equipment usually contain strong acids and/or strong oxidizing agents. They are highly toxic and very corrosive, and can cause severe skin burns. Prepare and use them with care. Never spill them on skin or clothing.

As a starting point, we recommend a solution that is composed of a combination of the two reagents used to oxidize the carbon. This solution is **50% of the used acid** (10% solution) and **50% sodium persulfate solution** (1.5 M) by volume.
This solution will normally remove accumulations of organic and inorganic carbon from the analyzer. However, plating, foaming, precipitation, or solidification problems are site-dependent, and must be handled on a site-by-site basis.
Site operators are urged to monitor their installations closely in the first days and weeks of operation for signs of precipitation, clouding, coating, or staining on the glassware that could indicate problems. The important thing is to catch problems early. If you observe rapid clouding or discoloration of the glassware and cannot dissolve it, contact your Endress+Hauser representative immediately. In such cases, it is frequently necessary for site operators to experiment with various chemical agents to identify the best possible combination. Detailed chemical analysis of the stream may be necessary to determine the cause of the problem. The Endress+Hauser Service Department may be able to provide assistance to you in the selection of more suitable cleaning agents for conditions at your site. However, there may be situations where it will be difficult or impossible to identify a cleaning agent that will perform satisfactorily.

Note!
Have your sample water or waste stream analyzed for chemical content and concentration **before** you install the analyzer so you will know what is in the waste stream.

Waste streams can contain a great number of different chemicals in highly variable levels of concentration. It would be impossible to predict all the possible chemical interactions that could occur inside a TOC analyzer. Endress+Hauser cannot be responsible for damage to the analyzer caused, in Endress+Hauser's opinion, by reactions of chemicals present in the stream or improper maintenance.

3.4 Post-installation check

- After installation, check that all connections are tightly fitted and are leak-resistant.
- Check all hoses for damage.

4 Wiring

4.1 Electrical connection

Warning!
- The electrical connection must only be carried out by a certified electrician.
- Technical personnel must have read and understood the instructions in this manual and must adhere to them.
- Ensure that there is no voltage at the power cable before beginning the connection work.

4.1.1 Preparing wiring

Warning!
- Ensure before connection that the mains voltage corresponds with the voltage specified on the nameplate.
- The unit must have its own dedicated, unswitched circuit.

Note!
To ensure that the cabinet remains resistant to dust and water, use appropriate conduits and fittings for all electrical connections.

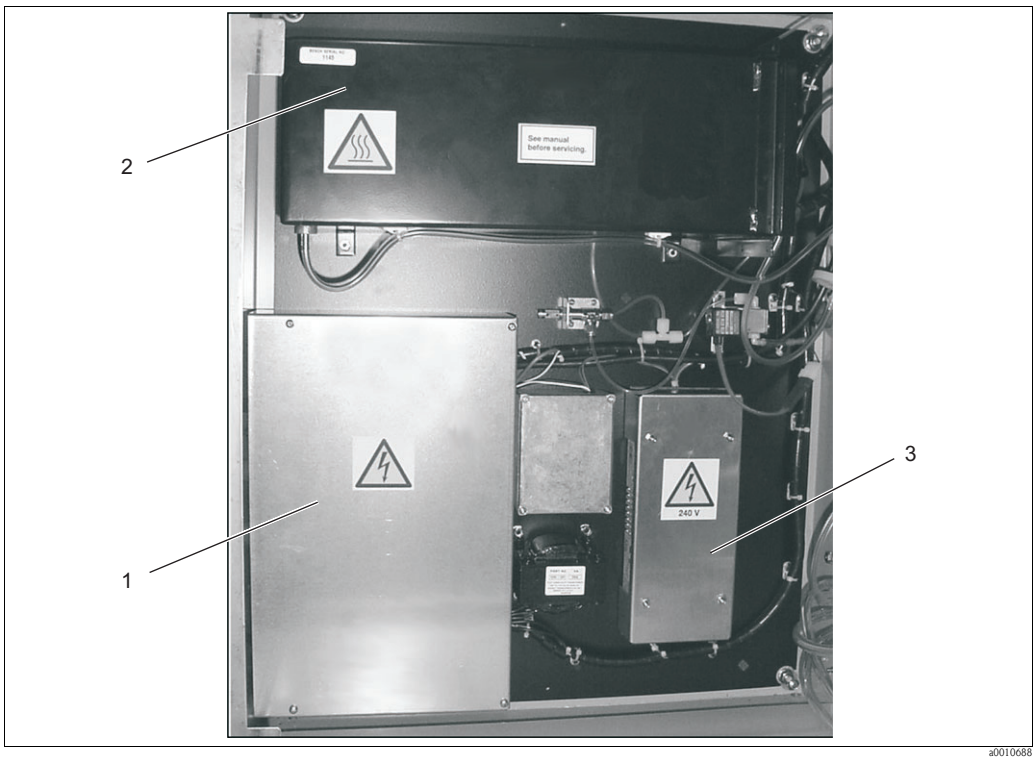


Fig. 7: Inside back of cabinet

1 Terminal box
2 Non-dispersive infrared detector (NDIR)
3 Power supply

The following connections must be made:

- AC power connection
- 4-20 mA analog output loop
- RS-232 serial loop (computer) connection
- Relay board connections

If you install the analyzer using conduit, use either rigid conduit or a flexible, liquid-tight conduit. Use the correct fittings with either type of conduit to maintain the resistance of the unit to liquid infiltration.
If you do not use conduit when installing the analyzer, use **cord-grip fittings**. These fittings use an elastomeric gland (bushing) around the cable which compresses around the cable while a nut is tightened on the fitting, to form a tight seal. However, please note that cord-grip fittings are specific to wire size. You must have the correct size for the cables you are using in the installation. You should also use sealing washers between the cord-grip fittings and the cabinet wall. Cord grip fittings are available from Endress+Hauser.

4.1.2 Electrical connection of analyzer

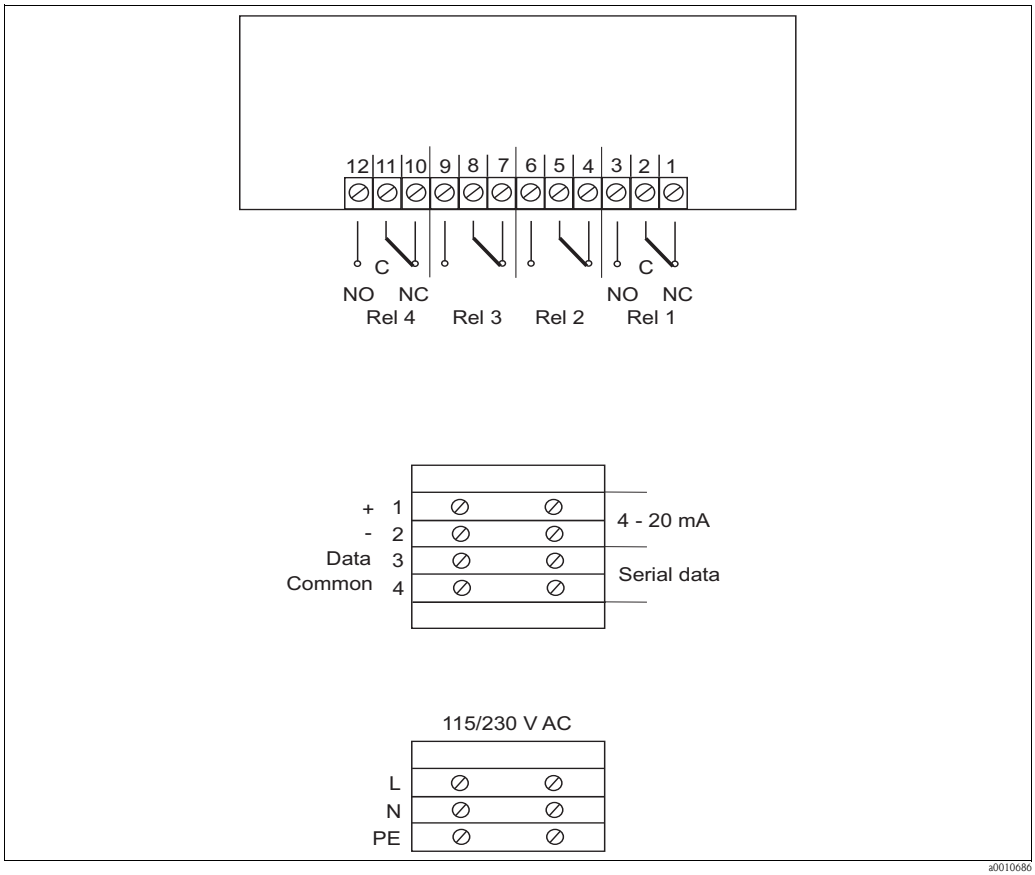


Fig. 8: Terminals

AC power

Power wire specification:
- Cross section at least 14 AWG or 1.0 mm^2
- Insulation rated for 60 °C (140 °F) or better

Connect the AC power cable according to Fig. 8. Place a tie wrap around them to hold them in position.

Note!
Note the small handles facing you on the left side of the terminal block. These handles are the levers for fuses. If you pull outwards on the handles, an insert that houses a fuse will pop out of the terminal block.

Power	Fuses
230 V AC	2 x microfuse 1.25 A, 250 V, slow-blow
115 V AC	1 x microfuse 3.0 A, 250 V, slow-blow

4.1.3 Connecting the signal outputs

Note!
To minimize electrical emissions and susceptibility to interference from other equipment, and also to comply with the European EMC directive, all cables connected to the 4 to 20 mA output, serial output, and relay outputs **must be shielded**. Additionally, the insulation on all interconnect cables should be rated for at least **300 volts**.
The maximum length of the serial output cable is 15.2 m (50 ft.)

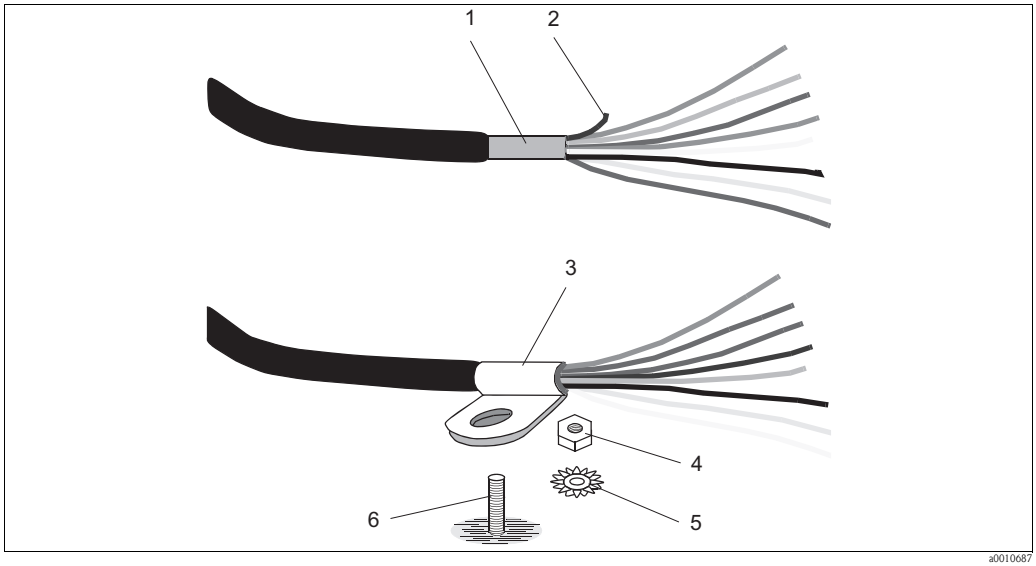


Fig. 9: Grounding shielded cable

1 Foil shield (width of the "P" clamp)
2 Ground wire (bare)
3 "P" clamp
4 Hex nut
5 Lock washer
6 Cabinet stud

Preparation of the shielded cable

1. Remove the outer jacket from the cable to provide enough wire to reach the appropriate terminal block.
2. Remove the foil shield, but keep the width of the "P" clamp.
3. Cut the ground wire to a length of approximately 1.3 cm (0.5").
4. Wrap the ground wire around the foil several times.
5. Fit the "P" clamp over the shield. When the clamp is fully closed, there should be a good tight connection to the foil shield and ground wire.

Installation of the shielded cable

1. Mount the "P" clamp to the stud closest to where the cable enters the analyzer cabinet.
2. Connect the cable according to the connection diagram.

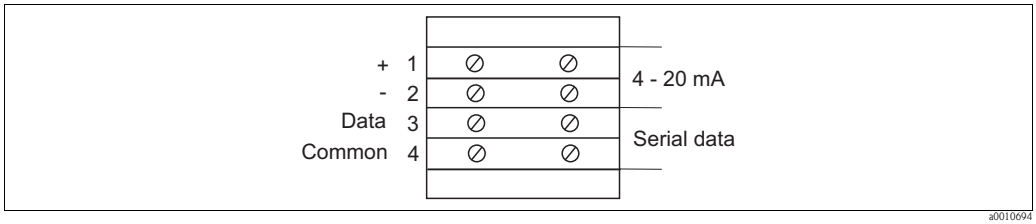


Fig. 10: Connection diagram

4.1.4 Connecting the relay outputs

- Each analyzer has either one or two relay boards.
- Each relay output is rated at max. 0.5 A, 24 VDC/240 VAC due to the current-carrying limitations of circuit boards.
- Each relay has a single set of form “C” contacts.

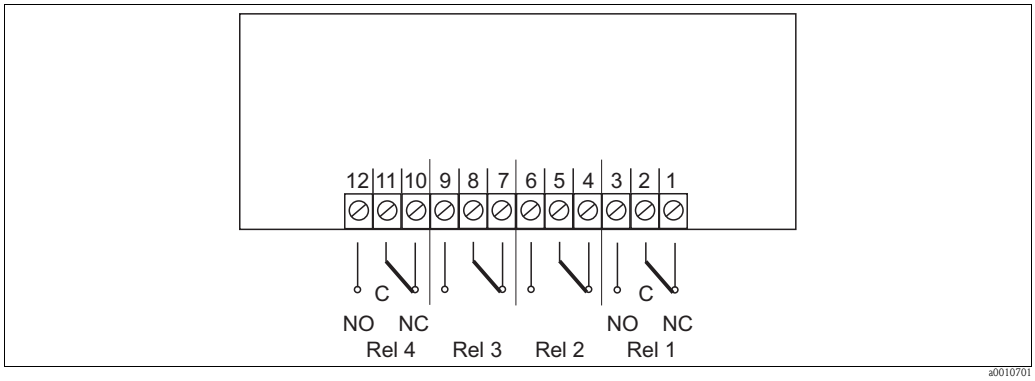


Fig. 11: Connection diagram

If a second relay board is installed, it is located on top of the first. Its connections will also be from right to left with relay #5 on the right.

4.2 Post-connection check

Carry out the following checks after electrical connection:

Device status and specifications	Note
Is the exterior of the analyzer or cable undamaged?	Visual inspection

Electrical connection	Note
Does the supply voltage correspond to the data on the nameplate?	230 V AC 50/60 Hz 115 V AC 50/60 Hz
Are current outputs shielded and connected?	
Are the mounted cables strain-relieved?	
Are the cable types properly separated?	Run power supply and signal lines separately over the entire travel distance. Separate cable channels are ideal.
Are the cables routed without loops or crossovers?	
Are power supply and signal lines connected correctly according to wiring diagram?	
Are all screw terminals tightened?	
Are all cable entries mounted, tightened and leak-resistant?	

5 Operation

5.1 Operating elements

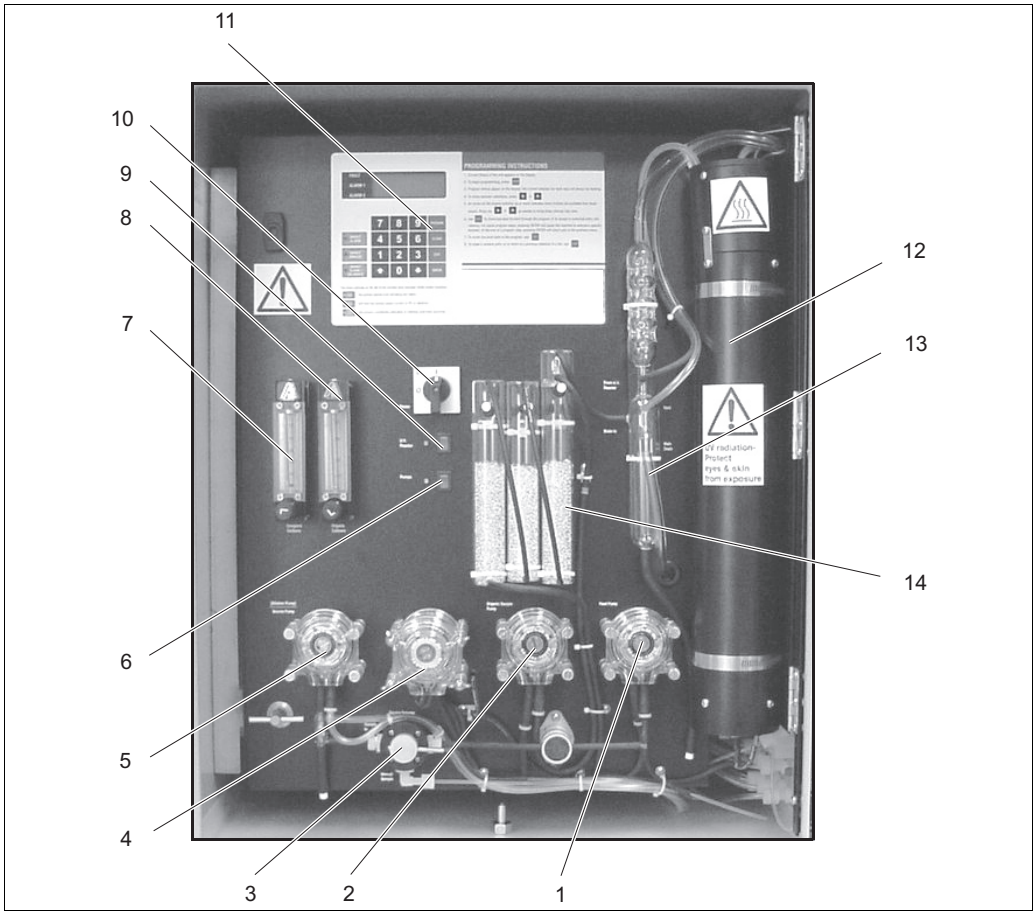


Fig. 12: Display and operating elements

1	Feed pump	8	"Organic carbons" flowmeter
2	Organic sample pump	9	"UV reactor" switch
3	Source selector	10	Power switch
4	Acid pump / oxidation pump	11	Display and keypad
5	Source pump	12	UV reactor
6	"Pumps" switch	13	Condenser column
7	"Inorganic carbons" flow meter	14	TIC scrubber (appearance may vary)

5.2 Display and keypad

The display shows:

- Measured value
- Programming menus.
- Status
- Failures and warnings

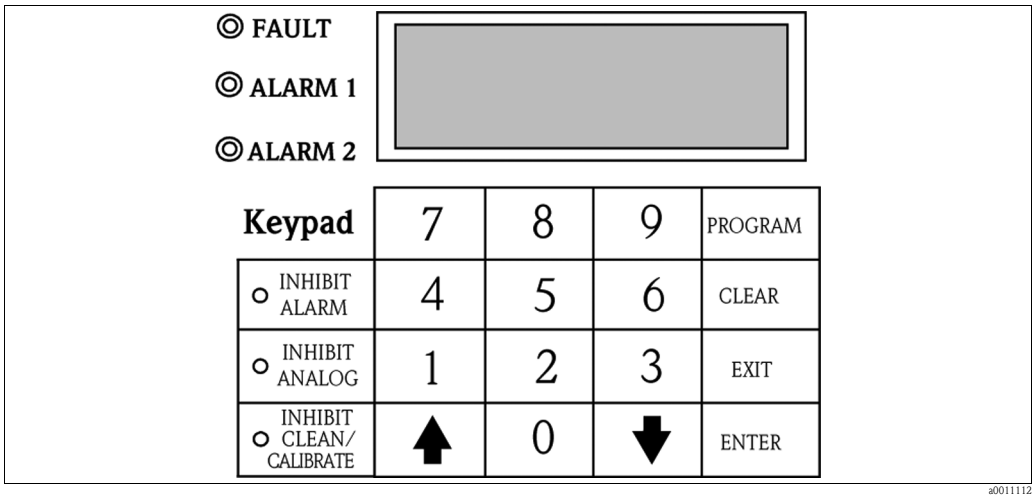


Fig. 13: Display and keypad

Key assignment:

- The number keys allow you to enter numeric values.
- The arrow keys allow you to move through the menus on the display. The menu item currently selected will be flashing.
- The PROGRAM key starts the program menus.
- The CLEAR key will return the display to the previously entered value, if you have not pressed ENTER.
- The EXIT key returns you to the next higher level menu. If you keep pressing the EXIT key, you will return to the normal operation display.
- The ENTER key saves the flashing entry.

6 Commissioning

6.1 Function check

Warning!
- Check all connections for correctness.
- Make sure that the supply voltage is identical to the voltage indicated on the nameplate!

6.2 Programming

6.2.1 COMMANDS menu

Display	Description
Start Calibration Start Clean Abort Cal/clean REAGENT TIMER Restart Pumps	**Start Calibration** manually begins a calibration cycle that is just like an auto-calibration. The analyzer will run deionized water and the standard calibrating solution through its cycle to recalibrate itself.
Start Calibration **Start Clean** Abort Cal/clean REAGENT TIMER Restart Pumps	**Start Clean** manually begins a cleaning cycle just like the auto-clean cycle.
Start Calibration Start Clean **Abort Cal/clean** REAGENT TIMER Restart Pumps	**Abort Cal/clean** stops a calibration cycle currently in progress. The analyzer will return to normal operation (measuring TOC). This function will also clear the following fault conditions if they are present: "Calibration Fail" and "IR Fault".
Start Calibration Start Clean Abort Cal/clean **REAGENT TIMER** Restart Pumps	**REAGENT TIMER** leads you to the following submenus.
ENTER TIMES RESET TIMER DISPLAY TIMER	**ENTER TIMES** leads you to the next submenu.
Total Time = XXX Hours Warning Time = XXX Hours	**Total Time** is the time period you expect the analyzer to operate for after you have filled the reagents. **Warning Time** is the time you select near the end of the cycle entered for "Total Time", to warn you that the reagents are running low.
ENTER TIMES **RESET TIMER** DISPLAY TIMER	**RESET TIMER** leads you to the next submenu.
Reset Timer? YES NO	This menu will also appear if you enter a new "Total Time". **YES** reloads the timer with the "Total Time" value. **NO** returns you to the previous menu.
ENTER TIMES RESET TIMER **DISPLAY TIMER**	**DISPLAY TIMER** leads you to the next submenu.

Display	Description
Remaining Time (days: hours: minutes)	**Remaining Time** shows the time remaining of the "Total Time".
Start Calibration Start Clean Abort Cal/clean REAGENT TIMER **Restart Pumps**	**Restart Pumps** puts the analyzer back online (if liquid is available) by restarting the pumps. If the analyzer detects a loss of flow, it will stop the pumps after 5 minutes and the unit will switch to offline status. This command is also used if the analyzer has gone offline due to a liquid leak.

6.2.2 CALIBRATION menu

Display	Description
STANDARD INHIBIT TIMES MANUALS	**STANDARD** leads you to the following screen.
Standard = XXXmg/L	This screen lets you set the concentration for the standard solution, Potassium Hydrogen Phthalate (KHP) or other chemicals, used by the analyzer for calibration purposes. You enter the value here that corresponds to the concentration of the solution you make up. Min. 50% max. 120% of the measuring range.
STANDARD **INHIBIT** TIMES MANUALS	**INHIBIT** leads you to the following screen.
TOTAL LEVEL	**TOTAL** leads you to the next submenu.
Inhibit All Cal/Clean YES NO	**YES** will inhibit all automatic calibration/cleaning cycles.
TOTAL **LEVEL**	**LEVEL** leads you to the next submenu.
Cal/Clean Inhibit Level = XXXmg/L	Enter a level of measured carbon. Above this level, the analyzer continues monitoring even when it is scheduled for a calibration or cleaning cycle. In such cases, it is more important to continue to monitor the flow than to go offline for calibration or cleaning.
STANDARD INHIBIT **TIMES** MANUALS	**TIMES** leads you to the following submenu.
START INTERVAL DELAY	**START** leads you to the following screen.
Calibration Start = XX:XX (time) XXX (date) Clean Start = XX:XX (time) XXX (date)	**CALIBRATION START**: Enter the start time for the first calibration of the unit. **CLEAN START**: Enter the start time for the first cleaning cycle of the unit. To check the next calibrate/clean cycle start times you may enter this screen at any time. The clean cycle should always be run before a scheduled calibration.
START **INTERVAL** DELAY	**INTERVAL** leads you to the following screen.
Calib. Interval = XX Hours XX Minutes Clean Interval = XX Hours XX Minutes	**CALIB. INTERVAL**: Enter the time between the first calibration and the next calibration. **CLEAN INTERVAL**: Enter the time between the first cleaning cycle and the next cleaning cycle.

Display	Description
START INTERVAL **DELAY**	**DELAY** leads you to the following screen.
Baseline Delay = XX Minutes Calib. Delay = XX Minutes Post-Calib. Delay = XX Minutes Clean Delay = XX Minutes Post Clean Delay = XX Minutes	**BASELINE DELAY**: Enter the time period during which the baseline is calibrated. During this time, deionized water flows through the analyzer to establish the baseline (0% point of concentration or zero set point). **CALIBRATION DELAY**: Enter the time period during which calibration is performed. During this time, the "standard" solution flows through the analyzer. The analyzer determines the 100% or full-scale set point. **POST-CALIB. DELAY**: Enter the time delay from when calibration ends to when sample measurement restarts. During this time, the sample solution flows through the analyzer. **CLEAN DELAY**: Enter the time period during which a cleaning cycle is performed. **POST CLEAN DELAY**: Enter the time delay from when the cleaning cycle ends to when sample measurement restarts. During this time, the sample solution flows through the analyzer
The following menus are for qualified personnel only. The menus allow you to adjust the liquid mixtures used to calibrate the unit. These menus are intended for use by skilled operators, such as a trained specialists from the vendor company, when carrying out a three- or six-month calibration inspection. These procedures should not be undertaken casually. ✎ Note! Do not perform a manual gas calibration! Manual gas calibration is performed by Endress+Hauser Service. **See the section "Calibration" for detailed calibration instructions.**	
STANDARD INHIBIT TIMES **MANUALS**	**MANUALS** leads you to the following submenu.
LIQUID CALIBRATION GAS CALIBRATION DISPLAY FACTORS ENTER FACTORS	**LIQUID CALIBRATION** leads you to the following screen.
STANDARD BASELINE	**STANDARD**: This runs the "standard" solution, Potassium Hydrogen Phthalate (KHP) or other chemicals, through the analyzer to establish the full-scale or 100% value in the liquid reactor section of the analyzer. Do this before setting the baseline. The following screen will appear:
Apply XX mg/L ENTER When Stable In = XX.X% Av = XX.X% Mn = XX.X% Mx = XX.X%	**In** is the "instantaneous" reading. **Av** is the "average" reading, which is derived from the previous 30 readings. **Mn** is the minimum reading from the last 30 readings. **Mx** is the maximum reading from the last 30 readings.

Display	Description
You must first prepare a standard that is equal in concentration to the full-scale rating of the unit. When finished, you can reset the "standard" to the calibration standard used in auto-calibration. The value will be close to the full-scale value for the analyzer. The display should read close to 100% ±5%. Adjust the ORGANIC CARBON air flow to get a reading as close to 100% as possible. Analyzers set up for 10 mg/l full scale may be more difficult to adjust because of their sensitivity. It is desirable to have the organic carbon air flow in the range of 80 to 100 ml/min. If the airflow required to achieve a reading of 100% is outside this range, adjust the air flow to bring it into the 80 to 100 ml/min range. It is acceptable for the displayed percentage for average (**Av**) to fall within a range of 75 to 125%, if this brings the air flow closer to, or within, the 80 to 100 ml/min range. Increasing the air flow (knob turned ccw) **decreases** the reading. Decreasing the air flow (knob turned cw) **increases** the reading. **Allow five minutes between adjustments for the unit to stabilize**. The compressed air added to the system serves as a gas propellant to move the CO_2 through the system, specifically from the ultraviolet reactor to the infrared analyzer. Note the following: ■ When performing a liquid calibration, it takes approx. 10 minutes for a reading to stabilize. This is because changes made at the "front end" of a system will take some time to work through the system. ■ When you increase the air setting, the CO_2 reading will decrease. This is because the increased air will effectively dilute the CO_2. It is not necessary to use a 100% standard. The analyzer will accept standards of 50 to 150% of the full scale. Mix the solution in accordance with the standard value you have chosen.	
STANDARD **BASELINE**	**BASELINE** is the setting for 0% carbon content. **See the section "Calibration" for detailed calibration instructions.** The following screen will appear.
Apply DI Water ENTER When Stable In = XX.X% Av = XX.X% Mn = XX.X% Mx = XX.X%	The DI (deionized) water contains no carbon; therefore, it is used to set the value for the zero setpoint. The value after it has stabilized should be less than **5%**. Wait for the **Av** value to stabilize. The **In** value may continue to change.
LIQUID CALIBRATION **GAS CALIBRATION** DISPLAY FACTORS ENTER FACTORS	**GAS CALIBRATION** will be performed by Endress+Hauser Service.
LIQUID CALIBRATION GAS CALIBRATION **DISPLAY FACTORS** ENTER FACTORS	**DISPLAY FACTORS** leads you to the following screen.
Liq Gain = 1.0000 Liq Offset = 0.0	The values in this display are the calibration factors resulting from the last liquid calibration. The liquid values will change when you perform a manual liquid calibration or when the analyzer performs an auto-calibration. Recording these values can give you an indication of aging that may occur in the analyzer.
Unable to Calibrate Not On-line	If a manual calibration is attempted when the unit is offline, the following message will appear as soon as the manual calibration command is entered. ("Not on-line" means conditions such as calibration, cleaning, or being offline due to a fault condition.)
Calibration Invalid Out of Range	If a manual liquid calibration is not successful because the factors calculated from it are too far out of range, this message will appear to alert you to this fact.

6.2.3 SETUP menu

The SETUP menu is programmed during installation of the analyzer. These menu values are generally not changed once the analyzer is installed. **They should be changed only by qualified personnel**.

Display	Description
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**CLOCK** leads you to the submenu.
HH:MM DD:MMM:YY (time) (date)	Enter the current time and date here. Enter the month as a number: Jan. = 1, etc.
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**ALARMS** leads you to the submenu.
ALARM 1 ALARM 2 ALARM 3 ALARM 4	ALARM 1 leads you to the next submenu.
Alarm 1 Delay = XX MIN TOC	A time can be entered using the number keys. This is the time delay which occurs from when the alarm level (shown on next screen) is reached to when the actual alarm is activated. This function can be used to screen out a momentary TOC level that is above the alarm level. When an alarm level is reached, the actual alarm is activated only after the time delay has elapsed. After setting the time delay, the level menu appears:
Alarm 1 Level = XXX mg/L TOC	Here you can select the level of carbon concentration required to trigger the alarm. What this alarm actually triggers is configured in a later section of the program. Note the letters TOC after the alarm level. This indicates that the unit is operating in TOC mode. You can set the mode to COD elsewhere in the program. If the setting is COD, the letters shown in the alarm level menus will be COD, as there are separate alarm levels for each TOC and COD alarm. If you switch between modes, the alarm levels will switch to the mode you selected. Even when a mode is not selected, the alarm levels are still saved. This means that if you switch back to that mode, you do not have to reenter the alarm levels.
There are four independent alarms. Selecting ALARM 2, 3, or 4 will show similar screens for each alarm.	

Display	Description
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**ANALOG OUTPUT** leads you to the next submenu:
ANALOG 1 ANALOG 2	The **ANALOG OUTPUT** menus determine the output of a current loop used to control industrial process equipment. The level of current in the loop varies with the changing level of carbon measured by the analyzer. Typically, the 0 or 4 mA current point is 0% or baseline, and the 20 mA point is the full scale. The purpose of this variable current is to provide an adjustable response from the process equipment to match the changes measured by the analyzer. **ANALOG 2** is an option that requires installation of additional hardware to operate. This menu will still be present, even without the hardware. Selecting **ANALOG 1** leads you to the next submenu:
CURRENT RANGE SCALING CAL/CLEAN ACTION INHIBIT ACTION	If you select **CURRENT RANGE** (available only for **ANALOG 1**) from the **ANALOG OUTPUT** menu, the following display will appear:
Current Range = 0 TO 20 mA 4 TO 20 mA	Whether you select 0 to 20 mA or 4 to 20 mA depends on the requirements of the process equipment controlled by your analyzer. **ANALOG 2** is 4-20 mA only, and so it is not possible to select a range.
CURRENT RANGE **SCALING** CAL/CLEAN ACTION INHIBIT ACTION	If you select **SCALING** from the **ANALOG 1 (2)** menu, the following display will appear:
Zero (4 mA) = XXX mg/L Full-Scale (20 mA) = XXX mg/L	This menu sets the zero (baseline) and full-scale (100%) carbon values for the analog output current. Note that these values are whatever you decide to set them to.
CURRENT RANGE SCALING **CAL/CLEAN ACTION** INHIBIT ACTION	If you select **CAL/CLEAN ACTION** from the **ANALOG 1 (2)** menu, the following display will appear:
Cal/Clean Action = ZERO LEVEL HOLD LEVEL	The **CAL/CLEAN** menu determines the level of analog output when the analyzer is offline (i.e. not measuring the sample) because it is either in a cleaning cycle or being calibrated. This menu gives you the option of dropping the analog output to zero (**ZERO LEVEL**) during a calibration or cleaning cycle, or having the output remain at the level it was at when the analyzer was measuring the sample prior to commencing the calibrate/clean cycle (**HOLD**). **ZERO LEVEL** is either 4 mA or 0 mA, depending on the current range you selected earlier.
CURRENT RANGE SCALING CAL/CLEAN ACTION **INHIBIT ACTION**	If you select **INHIBIT ACTION** from the **ANALOG OUT** menu, the following display will appear:
Inhibit Action = ZERO LEVEL HOLD LEVEL	The **INHIBIT ACTION** menu is similar to **CAL/CLEAN ACTION**, but is used when the analog output is inactive because the analog inhibit switch has been activated. This is to prevent unusual changes in the 4 to 20 mA loop that could have detrimental effects on the operation of equipment controlled by the loop. Selecting **ZERO LEVEL** will drop the Analog Output Loop to zero. Selecting **HOLD LEVEL** will cause the analog output loop to maintain the same current as provided from the last valid reading.

Display	Description
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**SERIAL OUTPUT** leads you to the next submenu.
BAUD DATA BITS PARITY STOP BITS REPEAT RATE	In the **SERIAL OUTPUT** menus, you make the necessary settings for communication with a computer or another digital device. Selecting **BAUD** leads you to the next submenu.
Baud = 300 600 1200 2400 4800 9600	Baud rates indicate the speed at which serial data are transmitted from the analyzer to a remote computer or other digital equipment. Select a Baud rate used by the computer or other digital device at the other end of the line.
BAUD **DATA BITS** PARITY STOP BITS REPEAT RATE	Selecting **DATA BITS** leads you to the next submenu.
Data Bits = 7 8	Again, select whatever is compatible with the computer or other digital device used with the analyzer in the installation.
BAUD DATA BITS **PARITY** STOP BITS REPEAT RATE	Selecting **PARITY** leads you to the next submenu.
Parity = NONE EVEN ODD	In this case also, selection depends on the setup of the computer you are using with the analyzer.
BAUD DATA BITS PARITY **STOP BITS** REPEAT RATE	Selecting **STOP BITS** leads you to the next submenu.
Stop Bits = 1 2	In this case also, selection depends on the setup of the computer you are using with the analyzer.
BAUD DATA BITS PARITY STOP BITS **REPEAT RATE**	Selecting **REPEAT RATE** leads you to the next submenu.

Display	Description
Repeat Rate = X H XX M XX S	The selection you make in the REPEAT RATE menu determines how often the serial data stream is transmitted from the analyzer. The number entered here is the time that elapses between the start of one serial data stream and the start of the next data stream. The unit will accept numbers from 1 second to 1 hour, 59 minutes, and 59 seconds.
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**PASSWORD** leads you to the next submenu.
All Keys Calib/Setup Menus No Password NEW PASSWORD	**All Keys** requires that you enter a password to operate any key on the analyzer. In normal operation, there are only four active keys: **PROGRAM**, **INHIBIT ALARM**, **INHIBIT ANALOG**, and **INHIBIT CLEAN/ CALIBRATE**. If you press any of these keys, the analyzer will request a password before performing any of these functions. This prevents unauthorized persons from operating the analyzer, as knowledge of the password is required. ■ **All Keys:** By entering a valid password, you can press one of the four active keys followed by another within one minute without having to enter the password again. ■ **Calib/Setup menus:** This password mode allows you to perform the functions of the normal mode keys (inhibit and program) without needing a password. You can also enter program mode and perform any of the operations under the **COMMANDS** menu without a password. You can go into the **CALIBRATION** and **SETUP** menus and view the settings within them. However, a password is required to change a value or setting. Once you have entered a valid password and you are working within the programming menus, you can make additional changes without the analyzer again requesting a password. If you exit the programming menus and then return to these menus, the first change you attempt to make will result in a password request. ■ **No Password:** This mode allows you to access all functions and menus and to make changes as desired without any passwords. There are exceptions, however. You must still have the special password to do gas calibration, and a password is always required for diagnostics. ■ NEW PASSWORD: Leads you to the next submenu.
New Password = XXXX	**NEW PASSWORD** allows you to change the password required in one of the above modes. You should be very careful to record the new password if you decide to change it. If you enter the correct pass number (originally 3500), the selection or value you want to change will be saved in the memory. If you enter an incorrect pass number, the unit will beep and the following display will appear.
Invalid Password	The screen will then revert to the menu in the program that is one level higher than the menu you were trying to change.

Display	Description
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**RELAY OUTPUT** leads you to the next submenu:
DELAY TIME RELAY ACTIVATION	Selecting **DELAY TIME** leads you to the next submenu:
DELAY 1 DELAY 2	If you select **DELAY 1** the following screen will appear:
Delay Time 1 = Xm Xs	You may enter a time in minutes and seconds. The delay functions can be used to set a time delay between the occurrence of a condition and the activation of a relay.
DELAY TIME RELAY ACTIVATION	When you go to **RELAY ACTIVATION**, you will find **DELAY 1** and **DELAY 2** listed along with the relays. Under each of these is the same list of conditions as those that can activate relays. You may select any of these conditions to start the delay. Then, under any of the relays, you can select that delay as its activating condition. When the condition occurs, it will activate the delay. When the time delay has elapsed, the programmed relay is activated. Selecting **RELAY ACTIVATION** leads you to the next submenu:
RELAY 1 RELAY 2 RELAY 3 RELAY 4 RELAY 5 RELAY 6 RELAY 7 RELAY 8 AND 1 AND 2 AND 3 AND 4 DELAY 1 DELAY 2	Note that relays 5 – 8 are optional; not all analyzers will have them. Note that a "+" (plus sign) appearing to the left of the word "**RELAY**" or "**AND**" or "**DELAY**" indicates that conditions have been programmed to activate that particular relay, AND, or delay. This allows you to determine quickly which relays/ANDs/delays have been programmed and which ones are still available. If you select any of the relays, the following screen will appear:

Display	Description
** RELAY X ** Alarm 1 Alarm 2 Alarm 3 Alarm 4 Loss Of Flow Scrub Gas Fail Reactor Gas Fail Liquid Leak Overrange Calibration Cleaning Unit Off-line Dilution Active Alarm Inhibit Analog Inhibit Cal/Clean Inhibit Reagent Warning IR Fault Power Fail Calib. Fail No Liquid Calib. Reactor Fault Timer 1 (or 2) Dilution 2 AND 1 AND 2 AND 3 AND 4 DELAY 1 DELAY 2	The X in **RELAY X** is the number of one of the four (or eight) relays available to you. Alternatively, it is the number of one of the four **AND** functions or one of the two **DELAYS** available in the analyzer. This list contains all the conditions you can select to activate a particular relay. ■ **Alarm 1 to 4** These are the level settings you entered for **ALARMS** earlier. This step assigns that condition to a specific relay. ■ **Loss of Flow** The analyzer has an internal flow detector that shuts down the pumps and turns off the UV lamp in the reactor chamber to protect the lamp and chamber. You can also use this condition to send a remote signal. ■ **Scrub Gas Fail** Indicates that gas is not going through the inorganic scrubber. ■ **Reactor Gas Fail** Indicates that gas is not going through the UV reactor chamber. ■ **Liquid Leak** The analyzer has a tray in the bottom with a liquid detector in it. The tray will catch leaks from the unit and signal this condition. ■ **Overrange** Indicates that the analyzer is detecting a greater level of carbon than it was designed to do. For example, if yours is a 1000 mg/l (full-scale) analyzer and the analyzer is detecting 1050 mg/l, it will activate the overrange signal. ■ **Calibration** The analyzer is offline and in a calibration cycle. ■ **Cleaning** The analyzer is offline and in a cleaning cycle. ■ **Unit Offline** Indicates that the unit is not measuring TOC. This results from any one of three different conditions: **Scrub Gas Fail, Reactor Gas Fail**, or **Loss Of Flow**. This offline condition does not include cleaning and calibration cycles, even though the unit is not measuring carbon during these operations. This offline condition results from a fault in the unit. ■ **Dilution Active** Activates an external (not supplied) dilution pump that will dilute the sample with deionized water whenever the reading exceeds a predetermined point. ■ **Alarm Inhibit** Refers to the control switch on the keypad. It prevents this function from occurring, instead keeping the unit online. ■ **Analog Inhibit** Refers to the control switch on the keypad. It prevents this function from occurring, instead keeping the unit online. ■ **Cal/Clean Inhibit** Refers to the control switch on the keypad. It prevents this function from occurring, instead keeping the unit online. ■ **Reagent Warning** The reagent timer has counted down to the warning time that you programmed. It is an indication that the reagents are low and will need to be replaced soon. ■ **IR Fault** Indicates a failure in the unit's IR detector. ■ **Power Fail** Indicates a failure in the unit's power supply. ■ **Calib. Fail** Indicates that the calibration results are out of tolerance. ■ **No Liquid Calib.** Indicates that the unit has not been calibrated with liquids (standard solution and DI water). The unit is still using default values for liquid calibration. ■ **Reactor Fault** Indicates a fault condition in the UV reactor temperature sensors ■ **Timer 1 (or 2)** Refers to the programmable timers that may be used to activate relay outputs. ■ **Dilution 2** Is a second dilution output.

Display	Description
The analyzer has one relay board with four "C" contacts. A second relay board is available (see the section "Accessories"). The relays are unassigned. To assign an activation condition to a relay: 1. Select a condition using the arrow key. 2. Save by pressing ENTER. A "+" sign will appear in front of the condition. The "+" sign indicates the activated condition. The relay will be activated whenever the condition becomes true. You can choose one of these conditions to activate the relay, or you can choose more than one condition to build an "activation list" for that relay. The conditions will be **logically OR'ed** together. To assign a "NOT" condition to a relay: 1. Select a condition using the arrow key. 2. Press the "zero" key. 3. Save by pressing ENTER. A "-" sign will appear in front of the condition. The relay will be activated whenever the condition becomes false. To remove a condition: 1. Select a condition with the arrow key. 2. Save with ENTER. The "+" or "-" sign in front of the condition will disappear. You can also combine the conditions with a logical **AND** function: 1. Select "AND 1" or "AND 2" to "AND 4" using the arrow key. 2. Press "ENTER". 3. Select the first condition with the arrow key. 4. Press "ENTER". A "+" sign will appear in front of the condition. 5. Select the second condition with the arrow key. 6. Press "ENTER". A "+" sign will appear in front of the condition.	
Relay Defaults Relay 1 — Alarm 1 Relay 2 — Alarm 2 Relay 3 — Loss Of Flow, Scrub Gas Fail, Reactor Gas Fail Relay 4 — Loss Of Flow, Scrub Gas Fail, Reactor Gas Fail, IR Fault, Calibration Fail, Reactor Fault Relay 5 — Calibration, Cleaning Relay 6 — Alarm Inhibit, Analog Inhibit, Cal/Clean Inhibit Relay 7 — Dilution Active Relay 8 — Overrange	
Power Fail Condition Special Considerations The power fail condition to activate a relay is a unique condition. When the condition is true, the correct power is no longer being supplied to the analyzer. Use the NOT condition for the Power Fail condition.	
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**DILUTION** leads you to the next submenu.
ENABLE CUT-IN LEVEL CUT-OUT LEVEL PUMP TIME CUT-IN TIME CUT-OUT TIME DILUTION FACTOR AUTO LEVEL ADJUST	**ENABLE** is a general enable for dilution. The menu below it provides **YES** and **NO** choices. **NO** will prevent dilution from becoming active under any circumstances and the other menu choices for **DILUTION** will have no effect. Selecting YES will allow DILUTION to operate according to whatever subsequent menu choices you make in the **DILUTION** menu.

Display	Description
ENABLE **CUT-IN LEVEL** CUT-OUT LEVEL PUMP TIME CUT-IN TIME CUT-OUT TIME DILUTION FACTOR AUTO LEVEL ADJUST	**CUT-IN LEVEL** is the carbon level that activates external dilution. When this point is reached, the condition **DILUTION ACTIVE** becomes true, and that condition can be used to activate one of the relays. Note that you must select **DILUTION ACTIVE** and one of the relays in the **RELAY OUTPUT** menu for anything to actually happen here. Once the condition to activate a relay has been true for a certain time period, the analyzer enters dilution mode.
ENABLE CUT-IN LEVEL **CUT-OUT LEVEL** PUMP TIME CUT-IN TIME CUT-OUT TIME DILUTION FACTOR AUTO LEVEL ADJUST	**CUT-OUT LEVEL** is the carbon level below which dilution will be turned off if it has been activated. Note that operation of this function is also affected by the **AUTO LEVEL ADJUST** option in this same **DILUTION** menu. If you select **YES** for **AUTO LEVEL ADJUST**, the cut-out level will be the actual carbon level in the undiluted stream, **not** the carbon level of the diluted sample that is flowing through the analyzer.
ENABLE CUT-IN LEVEL CUT-OUT LEVEL **PUMP TIME** CUT-IN TIME CUT-OUT TIME DILUTION FACTOR AUTO LEVEL ADJUST	**PUMP TIME** is the programmable time that occurs in tandem with the **CUT-IN TIME**. It is used through a relay to control an additional external pump in certain high-range configurations.
ENABLE CUT-IN LEVEL CUT-OUT LEVEL PUMP TIME **CUT-IN TIME** CUT-OUT TIME DILUTION FACTOR AUTO LEVEL ADJUST	**CUT-IN TIME** is the time it takes the unit to transition into dilution. This time starts one minute after the carbon level rises above the cut-in level. How the transition occurs depends on the setting for **AUTO LEVEL ADJUST**. If **NO** was selected, the **CUT-IN TIME** will simply be the minimum time the analyzer will be in dilution mode. The unit will not be able to exit from dilution mode during this time, even if the carbon level falls below the **CUT-OUT LEVEL**. If **AUTO LEVEL ADJUST** is set to **YES**, this time will be the time period for which the analyzer holds the carbon level reading. This time should be set for the proper interval required for the diluted sample to work its way through the analyzer. **CUT-IN TIME** can be set from one minute to 59 minutes.
ENABLE CUT-IN LEVEL CUT-OUT LEVEL PUMP TIME CUT-IN TIME **CUT-OUT TIME** DILUTION FACTOR AUTO LEVEL ADJUST	**CUT-OUT TIME** may also be set from one to 59 minutes. It will not affect the operation of the unit if **NO** was selected for **AUTO LEVEL ADJUST**. In this mode, dilution will end when the carbon level falls below the **CUT-OUT LEVEL** for at least one minute. When **YES** is selected for **AUTO LEVEL ADJUST**, the **CUT-OUT TIME** becomes the transition time out of dilution after the carbon level has fallen below the **CUT-OUT LEVEL**. This value should be set to the time it takes for the full-strength sample to work its way through the analyzer. During this time period, the carbon reading will be held constant.
ENABLE CUT-IN LEVEL CUT-OUT LEVEL PUMP TIME CUT-IN TIME CUT-OUT TIME **DILUTION FACTOR** AUTO LEVEL ADJUST	**DILUTION FACTOR** is the ratio of dilution water to the sample. If three times as much dilution water is added to the sample, the ratio of dilutant to sample is 3:1. The concentration in the resulting solution is ¼. The maximum allowable value is 50:1
ENABLE CUT-IN LEVEL CUT-OUT LEVEL PUMP TIME CUT-IN TIME CUT-OUT TIME DILUTION FACTOR **AUTO LEVEL ADJUST**	**AUTO LEVEL ADJUST** makes the analyzer display the actual carbon level in the sample stream when dilution is turned on. **AUTO LEVEL ADJUST** works by multiplying the carbon value measured in the diluted sample by the dilution factor. The displayed value and the value transmitted in the serial stream are affected by **AUTO LEVEL ADJUST**. Alarm settings, Calibrate/Clean values and the analog output settings will not change.

Display	Description
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	The analyzer takes a reading every second. However, the displayed value can be a reading averaged out over a much longer time period. In some installations, a "smooth" output that does not show small, rapidly changing events is preferred. Other installations may need a quick response to a sudden change. An example of this would be installations where spills are possible and it is necessary to respond quickly to them. **DISPLAY AVERAGING** allows you to choose the time period for averaging the displayed reading, as well as the analog output current. **DISPLAY AVERAGING** leads you to the next submenu.
Averaging Display Over 90 Seconds	Enter a number between 1 and 200. The displayed value will be an average value taken over the selected time period. For a "smooth" response, select a large number. For example, 180 will be three minutes. It will reduce small peaks and valleys and will give a smoother output that still shows an overall trend. The factory setting (default) is 90 seconds.
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**TIMERS** leads you to the next submenu.
TIMER 1 TIMER 2	The menus available for defining the operation of both timers are identical. **TIMER 1** leads you to the next submenu.
ON TIME OFF TIME STATUS (STOP) (START TIME)	**ON TIME** leads you to the next submenu.
On Time = XX H XX M XX S	The ON TIME (output activated) menu allows a time to be entered in hours, minutes, and seconds. This time may be a maximum of 12 hours, 59 minutes, and 59 seconds.
ON TIME **OFF TIME** STATUS (STOP) (START TIME)	**OFF TIME** leads you to the next submenu.
Off Time = XX H XX M XX S	Operation of the **OFF TIME** menu is the same as that of the **ON TIME** menu.
ON TIME OFF TIME STATUS (STOP) **(START TIME)**	**START TIME** leads you to the next submenu.

Display	Description
Start Time = (time) (date)	The **START TIME** menu allows you to enter a future time at which the timer will start operation. The **START TIME** menu will appear when the timer is not running. This includes the periods when the timer is stopped and when a start time has been entered but not yet reached, with the result that the timer has not started. During this pending time, the **START TIME** menu can be accessed to allow the start time to be changed to a different time. Once the start time is reached and the timer starts, the **START TIME** menu is no longer available, as it is not needed.
Enable Start Time = YES NO	Once you have entered a start time, a menu will appear asking if you want to enable the start time. Selecting **YES** will allow the analyzer to start the program at the programmed time. Once you have entered and enabled a start time, the **STOP** menu will appear.
Stop Timer 1 YES NO	This option allows you to stop the timer at any time. You can stop the timer after entering and enabling a start time, even if the start time has not yet been reached. You can also stop the timer after it has begun to run. The **STOP** menu is the only way to stop a timer. Otherwise, the timer will continue to run indefinitely once it has started until you select the **STOP** menu. An additional menu under the **STOP** menu requires that **YES** be selected in order to stop the timer.
ON TIME OFF TIME **STATUS** (STOP) (START TIME)	**STATUS** leads you to the next submenu.
Timer 1 Status Start: START PENDING Start Time: (time) (date)	The **STATUS** menu consists of two screens of data regarding the status of the timer. The top line of the first screen identifies the timer as 1 or 2. The second line is the current state of the timer. It can be on, off, stopped, or "start pending". The third and fourth lines depend on the status of the timer. If it is stopped, nothing will appear on these lines. If a start time is pending, these lines will show the start time. If the timer is running, these lines will show the remaining time in the current on or off cycle. The second screen of the **STATUS** menu is as shown in the following display:
Relay Number 1 2 3 4 5 6 7 8 AND Number 1 2 3 4	This screen shows which of the relays and AND conditions have been programmed to be activated by this timer. The second line shows the numbers of the relays this timer has been programmed to activate. The numbers 1 through 8 can appear on this line. The fourth line can have the numbers 1 through 4 for the four possible AND conditions.
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**MODE** leads you to the next submenu.
SELECT MODE ENTER LK	SELECT MODE leads you to the next submenu.
TOC-1 Stream * COD	**TOC-Stream** is the standard operation: measuring TOC and displaying it. Another parameter that can be measured is COD (Chemical Oxygen Demand). This may be correlated to TOC in a laboratory. If you want to display such a correlated value, choose *COD. The analyzer will still measure TOC but will multiply the measured value by a factor and display it as *COD. The factor used is entered in the next menu, **ENTER LK**.

Display	Description
SELECT MODE ENTER LK	ENTER LK leads you to the next submenu:
COD Multiplier (LK) = X.X Use Ø for decimal point	Here you enter the multiplier that will change the TOC number to be displayed as a COD value. The range for the multiplier is 0.1 to 10.0.
CLOCK ALARMS ANALOG OUTPUT SERIAL OUTPUT PASSWORD RELAY OUTPUT DILUTION DISPLAY AVERAGING TIMERS MODE LANGUAGE	**LANGUAGE** leads you to the next submenu.
English German Italian French	Select the appropriate language.

6.2.4 DIAGNOSTICS menu

The DIAGNOSTICS menus are used by Endress + Hauser Service to troubleshoot the instrument.

6.3 Communication

The analyzer has an RS-232 serial output with a repeating string of ASCII characters. The following is a description of the characters and their location in the string:

Characters	Description
1 -6	This is the full-scale TOC in mg/l (ppm). There are no leading zeroes. Unneeded characters are left blank.
7	Blank (unused character)
8 - 13	Current TOC of "Stream 1" as a decimal fraction of the full scale, with 1.000 being the maximum (e.g. 0.7124).
14	Blank (unused character)
15 - 20	Current TOC of "Stream 2" as a decimal fraction of the full scale, with 1.000 being the maximum (e.g. 0.7124). It will be zero if it is a single stream system.
21	Blank (unused character)
22 - 24	Operating status of the unit. It will always begin with the character "A:". The following states are: 0 = on-line 1 = cleaning 2 = calibrating 3 = offline 4 = manual calibrating 5 = auto gas calibrating IR analyzer (e. g. A:0)
25	Blank (unused character)
26 - 38	Current time and date. Note that the sixth character will always be "B". (e. g. 12:34B22SEP04, which is 12:34 PM on the 22nd of September, 2004)
39	Blank (unused character)
40 - 52	Start time of the next cleaning cycle. The sixth character will always be "C". (e. g. 12:00C23SEP04)
53	Blank (unused character)
54 - 66	Start time of the next calibration cycle. The sixth character will always be "D". (e. g. 13:00D23SEP04)
67	Blank (unused character)
68 - 75	Activating level for "Alarm 1". It will always begin with character "E". (e. g. E:8000)
76	Blank (unused character)
77 - 84	Activating level for "Alarm 2". It will always begin with character "F". (e. g. F:6000)
85	Blank (unused character)

Characters	Description
86 - 93	Inhibit level "Calibrate/Clean". It will always begin with character "G". (e. g. E:8000)
94	Blank (unused character)
95 - 102	Number of minutes remaining for the reagent timer. It will always begin with character "H". (e. g. H:144000)
103	Blank (unused character)
104 - 138	These are all the letters of the alphabet representing the conditions that can activate relays. Some letters are used twice, so pay attention to the character location. If the letters appear in upper case, the condition is true (condition has occurred). If they appear in lower case, the condition is false (has not occurred). The conditions are as follows: A = Alarm 1 B = Alarm 2 C = Alarm 3 D = Alarm 4 E = Loss of flow detected F = Loss of scrub gas detected G = Loss of reactor gas detected H = Liquid leak detected I = Overrange J = Unit currently in calibration K = Unit currently cleaning L = Unit offline M = Dilution active N = Alarm inhibited O = Analog output inhibited P = Calibration / cleaning inhibited Q = Reagents low warning R = IR fault S = Power failure T = Calibration fault U = No liquid calibration V = Reactor fault W = Timer 1 X = Timer 2 Y = Stream 1 Z = Stream 2 A = Stream 1 active B = Stream 2 active C = 2 stream pass / fail D = AND 1 E = AND 2 F = AND 3 G = AND 4 H = Delay 1 I = Delay 2
139	Blank (unused character)
140	Carriage return

Characters	Description
141	Line feed

7 Maintenance

It is necessary to perform maintenance on a regular basis to keep the analyzer operating efficiently.

Warning!
You must have a thorough understanding of the maintenance procedures before attempting service. All maintenance procedures described in this section should be performed only by a qualified service technician. Incorrect service could cause inaccurate operation, and could also create safety hazards.

Preventive maintenance is divided up as follows:
- 14-day (biweekly) maintenance
- 30-day (monthly) maintenance
- 90-day (quarterly) maintenance
- 180-day (semiannual) maintenance (performed by Endress+Hauser Service)
- 360-day (annual) maintenance (performed by Endress+Hauser Service)

As you use your analyzer, you may find that some inspections need to be done at a different frequency than our suggested time intervals. Make adjustments according to your specific needs, but always perform maintenance on a regular basis!

Flow diagram

Use this diagram as a reference when replacing or reconnecting tubing.

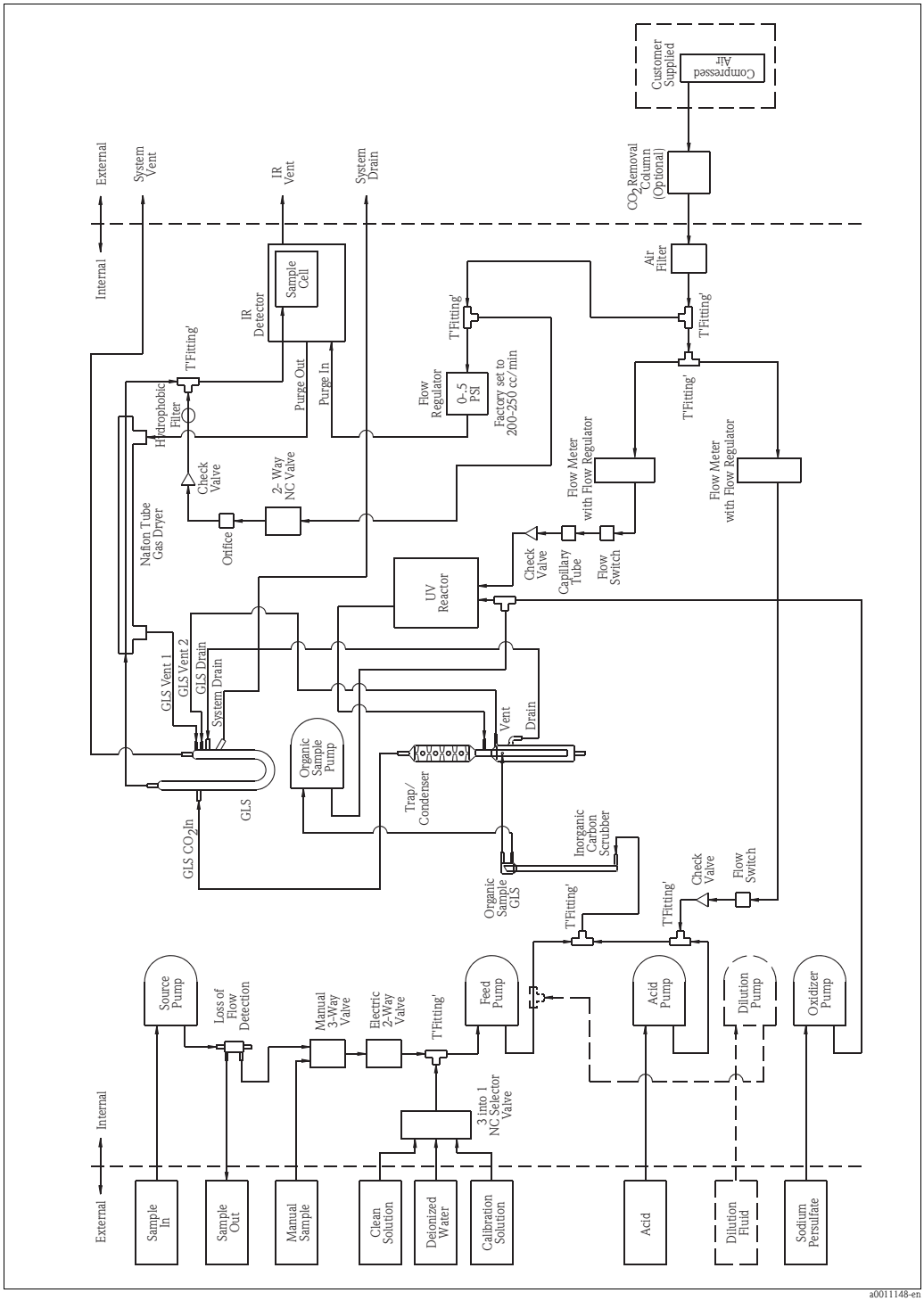


Fig. 14: Flow diagram

7.1 Biweekly maintenance

Every two weeks you must replace the standard solution and the deionized water. Prepare the standard as described in the section "Preparing chemicals".

7.2 Monthly maintenance

The following tasks must be performed:
- Replenish reagents
- Reset reagent timer
- Inspect entire unit

7.2.1 Replenish reagents

Every thirty days you will need to replenish the acid and oxidizing reagents used in the analyzer. These are 10% (v/v) phosphoric acid (H_3PO_4) and sodium persulfate ($Na_2S_2O_8$). Prepare the solutions as described in the section "Preparing chemicals".

7.2.2 Reset reagent timer

Follow the steps below to reset the reagent timer. For detailed information, refer to the instructions in the section "COMMANDS menu".
From the **COMMANDS** menu, select **REAGENT TIMER** to display the menu shown below:

```
ENTER TIMES
RESET TIMER
DISPLAY TIMER
```

Selecting **RESET TIMER** leads to the following submenu:

```
Reset Timer?
YES
NO
```

Select **YES** to reload the timer with the "total time" value from the **ENTER TIMES** menu.

7.2.3 Inspect entire unit

- Check that the display reads **ON LINE**.

```
CARBON: XX mg/l
STATUS: ON LINE
Internal Temp = XX °C
(present time), (date)
```

- Check that all pumps are running.

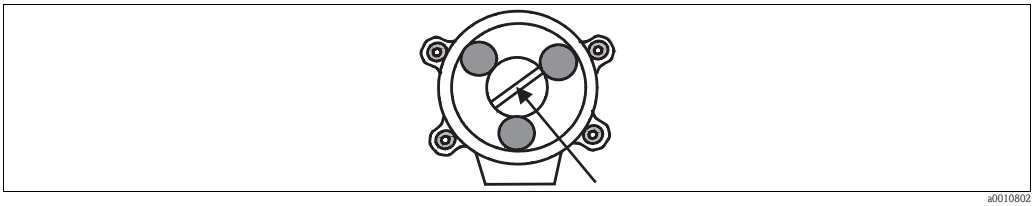


Fig. 15: Check slot for pump rotation

The pumps do not rotate rapidly, and they do not all turn at the same speed. However, they should all be rotating in a counterclockwise direction.

■ Check that the reactor is still active.

Warning!
Protect your eyes. Do not look directly at the UV lamp when the unit is running. UV radiation can cause serious eye damage, as well as skin inflammation.

Check the reactor by looking briefly into the top of the black or blue cylinder. The fittings in the bottom of the reactor should give off a pale light, indicating that the UV lamp is operational. Liquid and gas output from the reactor should also be present.

■ Check for leaks.

Warning!
Disconnect the power supply to the analyzer before servicing. This is done either at the breaker panel or by pulling the fuses inside the cabinet. Always shut down the analyzer before inspecting the tubing inside the cabinet. Drain all liquid lines and flush with water before replacing any tubing.

The analyzer has a built-in leak detector that will warn of serious or prolonged leakage. Nevertheless, inspect all tubing and connections to make sure there is no evidence of leakage. Pay particular attention to the tubing that passes through each pump. This tubing is under the greatest stress because it is flattened against the side of the case by the pump rollers each time the pump rotates.

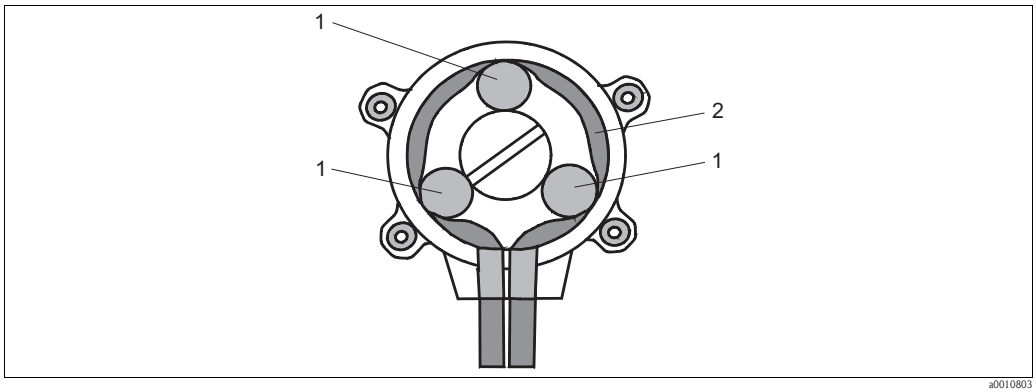


Fig. 16: Routing of pump tubing through rollers

1 Rollers
2 Tubing routed through pump

7.3 Quarterly maintenance

The following tasks must be performed:
- 30-day maintenance routine
- Replacement of all pump tubing
- Internal cleaning of analyzer
- Leak-testing of scrubber gas lines
- Leak-testing of UV reactor gas lines
- Leak-testing of IR purge / gas dryer counterflow lines
- Manual liquid calibration
- Automatic cleaning
- Automatic calibration
- Running zero water
- Running span (full-scale) standard solution
- Running alarm standards

The following materials will be required to perform the 90-day maintenance routine:
- Tubing (for the pumps and for test purposes)
- TOC standard solutions made up to exceed Alarm 1 level and Alarm 2 level and to equal the full scale (span)
- Appropriate general cleaning agents
- Vacuum cleaner
- Multimeter

7.3.1 Replacement of pump tubing

Warning!
Do not attempt to disassemble the pumps when power is running. You could injure your fingers if they get caught in the pump rollers.

Note!
To avoid the possibility of making incorrect tubing connections, remove only one pump head at a time. Change the tubing and then reconnect that pump.

Preparation

1. Remove the acid and persulfate lines from their respective bottles.
2. Feed water (either DI or tap) through the analyzer for about 10 minutes to purge the two chemicals from the system.

Disassembling the pumps

1. Shut off the analyzer.
2. Remove the thumbscrews from the pump head.
3. Disconnect the pump tubing
4. Pull the pump head straight off the analyzer.

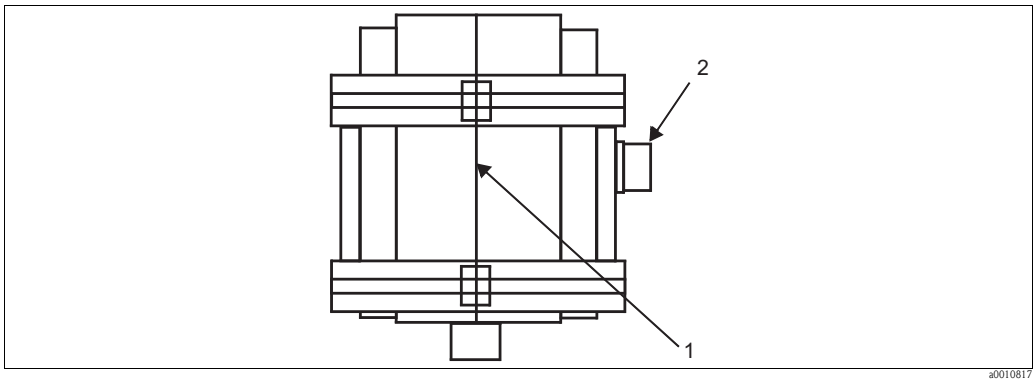


Fig. 17: Side view of pump body

1 Separate pump halves along this line
2 Drive shaft

5. Holding the pump in both hands, separate the halves by twisting each half in opposite directions and pulling apart gently.
6. Remove the old tubing.

   ✎ Note!
   When you disassemble the pump, note the two white washers between the pump shaft and the bearings. These washers prevent binding when the pump is operating. Do not discard the washers. Be sure to reinstall them when reassembling the pump.

Reassembling the pumps

1. Press the new tubing around the rollers, working your way around all three rollers and the pump body. Note that it does not matter which half of the pump contains the rollers. Try to center the tubing on the rollers as much as possible.
2. Press the two halves of the pump body back together. If the strength of the new tubing prevents the two halves from coming together completely, it may be helpful to rotate the pump shaft with a pair of pliers while you press the two halves together.
3. Reinstall the pump head.
4. Reconnect the tubing.
5. Reattach the four thumbscrews.

Repeat this process for all the other pumps on the analyzer.

7.3.2 Internal cleaning of analyzer

1. Shut off the analyzer.
2. Vacuum the inside of the cabinet. Be careful not to disturb any of the glassware, tubing or wiring inside the cabinet.
3. Clean the analyzer window with water-based spray-on window glass cleaner and a soft cloth. Never use paper towels, cleaners containing abrasives, petrochemical-based solvents, or halogenated solvents. Paper towels and abrasives will scratch the window, which is made of polycarbonate. Petro-solvents and halogenated solvents may damage the plastic.

7.3.3 Leak-testing of gas lines

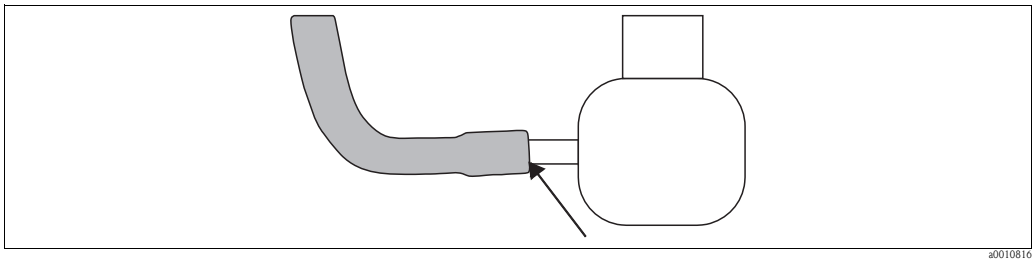


Fig. 18: Leak detection

Leak check the scrubber, UV reactor, and IR purge gas lines as follows:

1. Make up a solution of liquid soap and water in a small container. The solution should be quite strong, with 25 % or more soap.

Caution!
Be very careful when working inside the unit to avoid contact with any electrical connections.

2. With a small, soft brush, paint the solution onto the connection points between the gas tubing and the glassware, reactor, and IR analyzer (Fig. 18).
3. Check for the formation of bubbles at the connection between the tubing and the fittings. Any bubbles found indicate leakage.
4. Replace any leaking tubing.
5. Clean non-leaking joints with a sponge or soft cloth to prevent the buildup of soap residue.

7.3.4 Manual liquid calibration

This procedure allows you to verify that the analyzer can determine the correct carbon concentration for both zero (deionized water) and TOC standard solutions. To perform a manual liquid calibration, proceed as follows:

Preparation

1. Mix a 1-liter container of the full-scale standard solution used in your analyzer (10, 100, 500, 1,000, 5,000, or 10,000 mg/l) according to the correct procedure.
2. Fill a 1-to 2-liter container with deionized water. Place both containers (the DI water and the standard solution) near the analyzer.
3. Connect a 1.5 to 3 m (5 to 10 ft.) piece of PFA tubing to the container of standard solution and the MANUAL SAMPLE input on the side of the analyzer.
4. Turn the SOURCE SELECTOR (located below the pumps) clockwise from the 3 o'clock position to the 6 o'clock position. This will allow the analyzer to draw in the standard solution through the MANUAL SAMPLE port.

Performing manual liquid calibration

1. Select the **CALIBRATION** menu. - Press **ENTER**.
2. Select the **MANUALS** menu. - Press **ENTER**.
3. Select **LIQUID CALIBRATION**. - Press **ENTER**.
4. Select **STANDARD.** - Press **ENTER**.
5. The display will show:

```
Apply XX mg/L
ENTER When Stable
In = XX.X% Av = XX.X%
Mn = XX.X% Mx = XX.X%
```

6. Wait until the display shows close to 80 to 90% of the full scale. This may take 20 to 30 minutes.
7. Adjust the ORGANIC CARBONS air regulator (located close to the power switch) to display 100 % ±3 %. Wait at least 5 minutes between adjustments, and only turn the regulator by 1/8 to 1/4 of a turn at a time. Turning the slot clockwise **increases** the TOC percentage displayed, while turning the slot counterclockwise **decreases** the TOC percentage displayed. When the **Av** (average) reading is 100 % ±3 % of the full-scale value, press **ENTER**.
8. Select **BASELINE**. - Press **ENTER**.
9. The display will show the following:

```
Apply DI Water
ENTER When Stable
In = XX.X% Av = XX.X%
Mn = XX.X% Mx = XX.X%
```

10. Remove the PFA tube from the container of standard solution, and rinse the last few inches of the end of the tube with DI water. Then insert the tube into the container of DI water.
11. Wait 30 to 40 minutes or until the displayed value falls to 0 + 3 % of the full scale. When the displayed value is stable within the specified range, press **ENTER**. If a value below 3 % cannot be obtained:
    – Check for air leaks.
    – Get fresh DI (deionized water) in a clean container.
    – Run cleaning solution for one hour and then try again.
12. Press **EXIT.** - Select **DISPLAY FACTORS**. - Press **ENTER**.

```
Liq Gain = 1.0000
Liq Offset = 0.0
```

13. The first line of the display shows the liquid gain. It is acceptable if it is in the range of 0.75 to 1.25. However, the preferred range for gain is 0.9 to 1.1. If the value is outside the preferred range, you may need to clean the analyzer thoroughly and have a gas calibration performed. The second line indicates the liquid offset. This value should be between –125 and +125. A value outside this range also indicates the need for maintenance. For 10 ppm full-scale units, the acceptable liquid gain may be as high as 2.5 to 3.0.
14. The display will now return to the **SELECT** menu. Press **EXIT** four times to return to the main display.

7.3.5 Automatic clean

This procedure allows you to verify that the auto-clean feature is operating correctly.

1. Connect a tube from a container of cleaning solution to the CLEAN SOLUTION inlet on the right-hand side of the analyzer.
2. Select **COMMANDS**. - Press **ENTER**.
3. Select **START CLEAN.** - Press **ENTER**.
4. Press **EXIT** to return to the standard display.

The display will show the following:
Status: Cleaning. The next line will flash between **Internal Temp: XX°C** and **Cleaning Delay: XX m**. The period of time the analyzer stays in clean mode is user-programmable in the **CALIBRATION – TIMES** menu.
The analyzer will now begin an auto-clean. After the clean cycle is finished, the unit stays in clean mode for a specified amount of time for a post-clean cycle (this time is also user-programmable). During the post-clean period, the unit pumps the sample through the system to return the system to where it was before the cleaning cycle. The unit will then return to normal operation, and the display will show **Status: On Line**.

7.3.6 Automatic calibration

This procedure allows you to verify that the auto-calibrate feature is operating correctly. You will need the following:

- **Standard solution** (appropriate for your unit, 10, 100, 500, 1,000, 5,000, or 10,000 mg/l carbon)
- **Zero or baseline solution** (preferably deionized water)

Procedure

1. Using tubing, connect these two solutions to the **Calibration** and **Deionized water** inlets on the right-hand side of the analyzer.
2. Select **COMMANDS**. - Press **ENTER**.
3. Select **START CALIBRATION**. - Press **ENTER**.
4. Press **EXIT** to return to the standard display.

The display will show:
Status: Calibrating. The next line will flash between **Internal Temp: XX°C** and **Calib Standard: XX m**. The period of time the analyzer stays in calibration mode is user-programmable in the **CALIBRATION – TIMES** menu. You can use the same time for auto calibration or manual calibration.
The analyzer will first run a gas calibration, which will last about five minutes.
The unit will then begin pumping in zero (baseline) solution, and the display will show: **Reading XXXX mg/l** and **Calib Baseline XX m**. The value should fall to 0 to 2 mg/l. This process will take 20 to 30 minutes at minimum. The analyzer will then pump in the standard solution. This will also take 20 to 30 minutes. The exact period of time depends on the length of time programmed into the unit and how the unit was configured. The display should show the full-scale reading for the unit, **Reading** XXXX mg/l.

7.3.7 Alarm Standards

Caution!
When testing for alarms, **temporarily** disable any equipment that would respond to an actual alarm in order to prevent an unintentional response. The easiest way to do this is to pull the terminal blocks from the relay boards. Turn off power before working inside the cabinet.

This procedure allows you to verify that the alarm and relay outputs are operating correctly. To run the alarm standards, you can follow the same procedure used to verify operation using the standard solution. However, this time use solutions formulated to have a higher concentration than is necessary to activate the alarms.

Caution!
Once you have completed the alarm tests, **make sure to reactivate** any equipment you disabled to test the alarms. This guarantees the correct response in the event of an actual alarm.

8 Accessories

90 / 180 day maintenance kit
- Includes the tubing for all pump head sizes
- Order number: 71092036

Set of service parts for annual maintenance PA-2
- Order number: 71013847

Set of service parts for annual maintenance PA-3
- Order number: 71013848

PA-2 piping without solenoids
- Order number: 71093894

PA-3 piping without solenoids
- Order number: 71093895

Solenoids for PA-2/PA-3, 115V AC
- Order number: 71093896

Solenoids for PA-2/PA-3, 230V AC
- Order number: 71093897

Carrier gas generator
- Order number 115 V AC: 71092115
- Order number 230 V AC: 71092116

9 Troubleshooting

9.1 Messages

The messages that are displayed indicate faults or other conditions. Each message will appear for two seconds. The unit cycles continuously through all current messages.

Message	Unit	Description
Reagents low	Hours, minutes	The time remaining before the reagents run out is less than the warning time.
C/C Inhibit	Minutes	The time remaining on the Calibrate/Clean Inhibit function. This timer (60 minutes) starts counting down when you press the C/C Inhibit switch. At zero the inhibition is lifted.
Cleaning Delay	Minutes	The unit is performing a cleaning cycle. The time shown is the time remaining in the first part of the cleaning cycle during which the unit is pumping cleaning solution through the system.
Post Cleaning	Minutes	The unit is currently in a cleaning cycle. The time shown is the time remaining in the last part of the cycle during which sample is being pumped through the analyzer. The measured carbon level will appear on line 1. Since the unit is not on-line, it will not transmit the measured carbon level.
Calib. Baseline	Minutes	The analyzer is currently performing a calibration. The time shown is the remaining time during which deionized water is pumped through the system.
Calib. Standard	Minutes	The analyzer is currently performing a calibration. The time shown is the remaining time during which the calibration standard (potassium phthalate) is pumped through the system.
Post Calib.	Minutes	The analyzer is currently performing a calibration cycle. The time shown is the remaining time in the second half of the cycle during which sample is pumped through the system. The measured carbon level will appear on line 1. Since the unit is not on-line, it will not transmit the measured carbon level.
Time to Clean	Minutes	This is the time in minutes before the next cleaning cycle starts. This message will appear on the display one hour before the start of the cleaning cycle. This message warns service personnel that they may need to inhibit the Calibrate/Clean cycle.
Time to Calibrate	Minutes	This is the time in minutes before the next calibration cycle starts. This message will appear on the display one hour before the start of the calibration cycle. This message advises service personnel that they may need to inhibit the Calibrate/Clean cycle.
Alarm Inhibit	Minutes	This is the time remaining during which the analyzer inhibits alarms. This timer starts counting down from 60 minutes when the alarm inhibit switch is activated.
Internal Temp.	Degrees C	This is the temperature of the air inside the cabinet.
Scrub Gas Fault		This indicates that gas flow to the inorganic scrubber has stopped.
Reactor Gas Fault		This indicates that gas flow to the ultraviolet reactor chamber has stopped.
Calib IR	Minutes	This is the beginning of an auto-calibration cycle. The IR analyzer is calibrated with zero gas.

Message	Unit	Description
Loss of Flow Fault		The analyzer has detected a loss of liquid flow through the source pump.
Analog Inhibit	Minutes	This indicates the remaining time during which the analyzer inhibits the analog current output. It starts counting down from 60 minutes when the INHIBIT ANALOG switch is activated.
Dilution Active		If external dilution has been enabled and the dilution cut-in level is exceeded, a signal is sent to start the external pump. This message indicates that the pump signal has been sent.
Holding Carbon	Minutes	If external dilution has been enabled and the unit is transitioning into or out of dilution mode, the displayed carbon level will be frozen until the dilution conditions stabilize. This message displays the remaining time in minutes during which the level will be maintained.
Overrange		The measured carbon level has exceeded the full-scale for the unit.
Calibration Fail - Liq		The correction factors for liquid calibration obtained by the unit from the last auto-calibration sequence were out of range and were not saved.
Liquid Leak		The analyzer has detected liquid accumulating in the drain pan at the bottom of the unit.
IR Fault		The analyzer has lost communication with the IR bench.
Not Liq Calibrated		This message indicates that a liquid calibration has not been performed on this unit. Changing the full-scale value of a unit invalidates its liquid calibration. When the full scale is changed, the liquid calibration values will revert to the default values, and this message will appear.
Reactor Fault		The unit is not reading values from temperature sensors inside the reactor. This is probably due to a failure in the sensors. The heaters in the reactor will shut down to protect the reactor.
Reactor Not To Temp		The reactor is not at the proper operating temperature.
Liq Detector Not Cal		The liquid detector has not been calibrated.

9.2 Spare parts

Spare parts for pumps

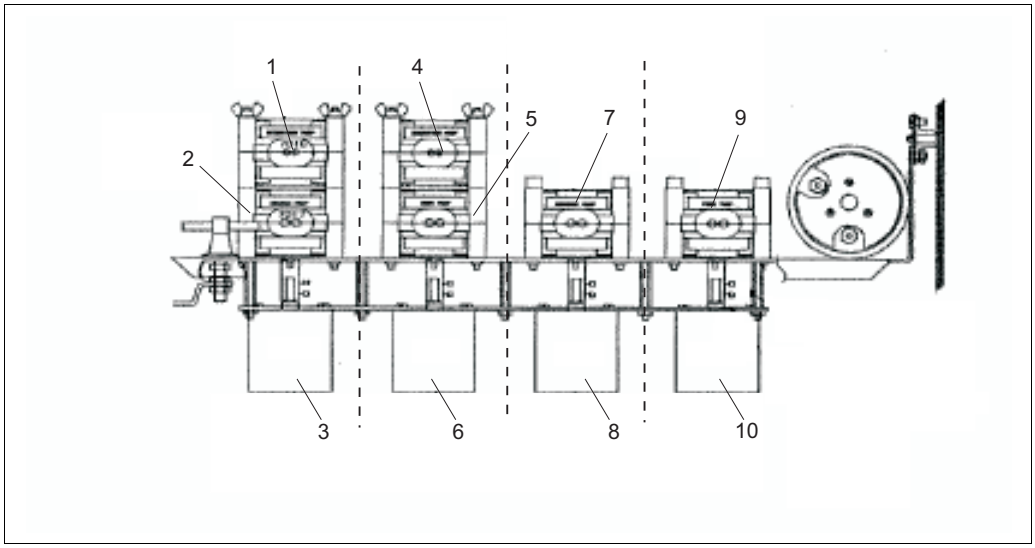


Fig. 19: Pump/motor assembly (from below)

1	Dilution pump head (only some configurations)	6	Acid/persulphate motor
2	Source pump head	7	Organic sample pump head
3	Source motor	8	Organic smple motor
4	Acid pump head	9	Feed pump head
5	Persulphate pump head	10	Feed motor

Pump/Motor	10 mg/l	100 mg/l	500 mg/l	1,000 mg/l	5,000 mg/l	10,000 mg/l
1	N/A	N/A	N/A	N/A	71091954	71091954
2	71091955	71091955	71091955	71091955	71091955	71091955
3	71091813	71091809	71091809	71091809	71091809	71091809
4	71091952	71091952	71091952	71091952	71091952	71091952
5	71091952	71091952	71091952	71091952	71091952	71091952
6	71091807	71091807	71091807	71091807	71091807	71091807
7	71091955	71091954	71091952	71091952	71091952	71091952
8	71091811	71091811	71091811	71091808	71091808	71091808
9	71091955	71091954	71091952	71091952	71091952	71091952
10	71091810	71091809	71091809	71091809	71091809	71091809

Additional spare parts

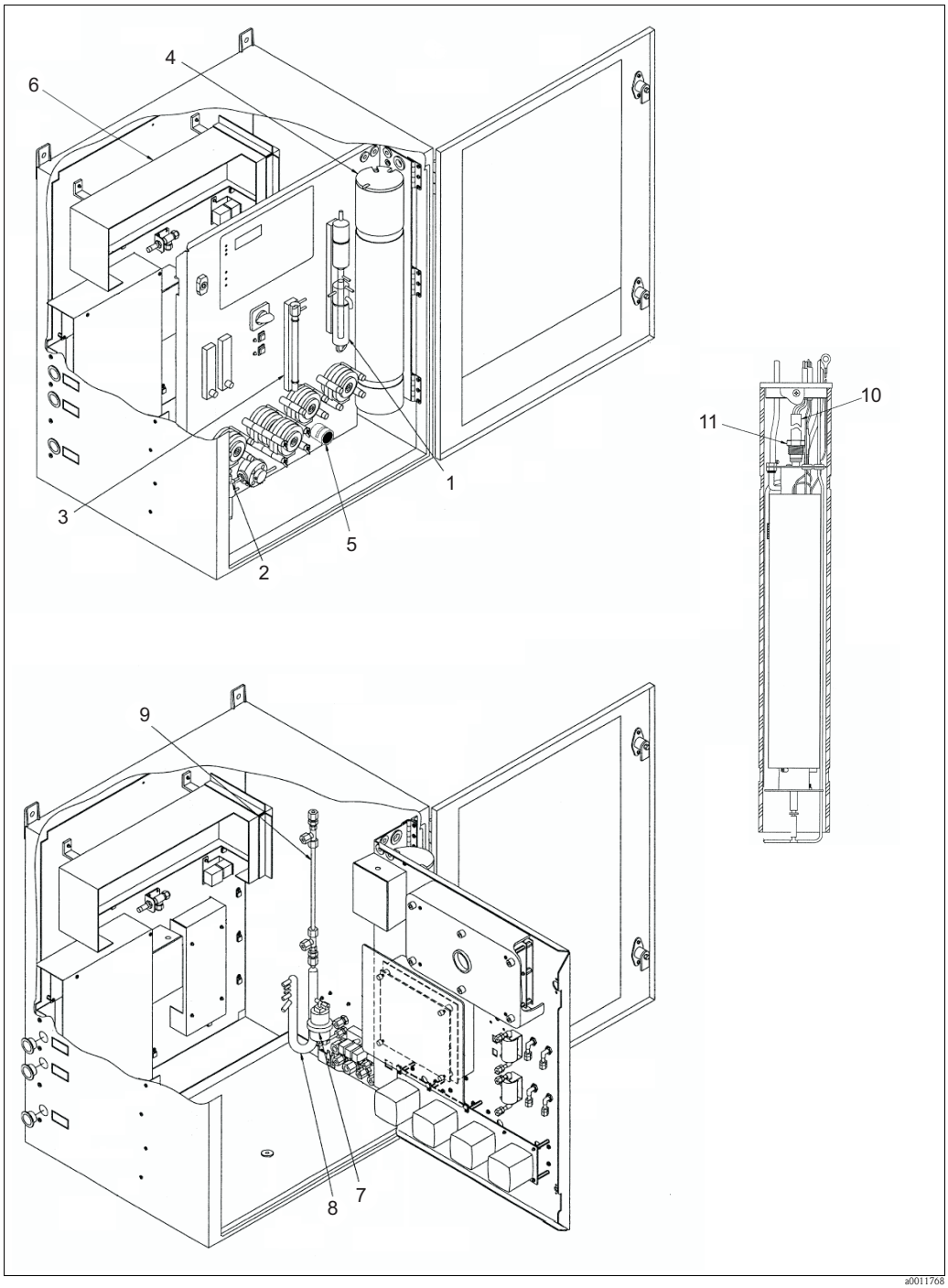


Fig. 20: Spare parts position

Position	Description and contents	Order number Spare parts kit
1	Glassware condenser column	71092016
2	Liquid detector assembly	71092021
3	Glassware inorganic C	71092015
3	Glassware sparging column	71092018
4	Glass reactor without UV lamp	71092033
5	Pinch valve 2/2-way 24 V DC	71092047
6	IR detector with flag digital	71092029
7	Filter assembly 1/8" NPT	71092038
8	Glassware system GLS	71092017
8	Glassware fast response GLS	71092019
9	Nafion gas dryer tube	71092353
10	UV lamp assembly	71092032
11	Reactor nut passivated	71092354

Description and contents	Order number Spare parts kit
Air flow switch monitor 0.5 A	71091958
Filter hydrophobic IR detector	71092039
Filter gas converter coalescing	71092040
Filter gas converter charcoal	71092041
Filter gas converter dust removal	71092042
All fittings interior	71092356
All fittings exterior	71092357
Extra fittings dual stream	71092358

9.3 Return

If the analyzer has to be repaired, please contact the responsible sales center.
If the analyzer has to be returned, please return it *cleaned* to the responsible sales center.
Please use the original packaging, if possible.

Please enclose the completed "Declaration of contamination" (copy the second last page of these Operating Instructions) with the packaging and the transportation documents.
No repair without completed "Declaration of contamination"!

9.4 Decommissioning

To decommission the analyzer, proceed as follows:

1. Connect the sample, acid and pesulfate lines to deionized water or tap water.
2. Run the analyzer for at least two hours with **all sources** connected to deionized water or tap water.
3. Once the two hours have elapsed, turn off the analyzer. Turn off the power and disconnect the power line. Allow the gas supply to continue flowing.
4. Disconnect all the liquid lines and drain the analyzer completely.
5. Disconnect the persulfate line at the pump outlet and drain the reactor.
6. Turn off the gas supply to the analyzer and disconnect the gas lines from the analyzer.
7. Make sure **no remaining liquid** is left anywhere inside the unit. This includes tubing, glassware and the reactor.
8. Clean and dry any spillages inside the cabinet or at the bottom.

When shipping the analyzer, use the original shipping crate. If the original shipping crate is no longer available, proceed as follows:

1. Place the analyzer on its back and bolt it to a strong pallet.
2. Construct a strong enclosure around the analyzer using plywood with a minimum thickness of 10 mm (3/8").

9.5 Disposal

The device contains electronic components and must therefore be disposed of in accordance with regulations on the disposal of electronic waste.
Please observe local regulations.

10 Technical Data

10.1 Input

Measured variable	TOC or TC	
Measuring range	**Version**	**Measuring range**
	A	0.015 to 10 mg TOC / l
	B	0.1 to 100 mg TOC / l
	C	0.5 to 500 mg TOC / l
	D	10 to 1000 mg TOC / l
	E	50 to 5000 mg TOC / l
	F	100 to 10000 mg TOC / l

10.2 Output

Output signal	0/4 to 20 mA
Interface	RS 232 unidirectional
Alarm	Two programmable alarm levels per channel with up to 8 programmable type C relays Type C relay: SPDT switch, isolated contacts; each contact is rated at 0.5 A @ 24 V DC / 230 V AC. Relay board with 4 relays is part of the system.
Programmable outputs	Up to 8 customer-programmable outputs on type C relays. Can be programmed to output any combination of multiple system parameters (including the four alarms).
Display	4-line, 20 characters per line, backlit liquid crystal display (LCD)

10.3 Power supply

Supply voltage	115 V AC ±10%, 50/60 Hz, 2 A, 230 VA 230 V AC ±10%, 50/60 Hz, 1 A, 230 VA	
Fuses	**Supply voltage**	**Fuses**
	230 V AC	2 x microfuse 1.25 A, 250 V, slow-blow
	115 V AC	1 x microfuse 3.0 A, 250 V, slow-blow

10.4 Performance characteristics

Accuracy	±1.5 % for TOC concentrations ranging from 0 to 75 % of the full scale ±2.5 % for TOC concentrations ranging from 75 to 100 % of the full scale
Response time	Less than 8 minutes to t_{90} at 100 mg/l configuration TOC
Repeatability	±1 % of full scale
Drift	±1 % of full scale over 72 hours without calibration at 20 °C (68 °F)
Temperature stability	Less than 2% of full-scale drift over ambient range of 10 to 30 °C (50 to 86 °F)
Inorganic carbon removal	≥ 95 %, when using standard TIC scrubber ≥ 98 %, when using ultra TIC scrubber

10.5 Environment

Ambient temperature range	> 0 to 40 °C (> 32 to 104 °F)
Humidity	max. 90 %
Ingress protection	IP 54
Storage conditions	Store in dry rooms only. Use appropriate packaging to store.

10.6 Process

Medium inlet pressure	Unpressurized; low overpressure of max 0.2 bar (2.9 psi) is permitted.
Medium outlet pressure	Unpressurized exhaust
Suspended solids	For particle sizes ≥ 200 µm, an appropriate sample preparation (e.g. PA-2 or PA-3) is required. 3 % maximum concentration of suspended solids by volume.
Flow volume	Max. 50 ml/min at 60 Hz
Reagents	1.5 M $Na_2S_2O_8$ (sodium persulfate), 10% (v/v) H_3PO_4 (phosphoric acid) or 5% HNO_3 (nitric acid), each in deionized water. Consumption: 19.7 l (5.2 US gal) / month each

10.7 Mechanical construction

Weight	approx. 73 kg (160 lbs)
Housing	IP 54

Index

Endress+Hauser

People for Process Automation

Declaration of Hazardous Material and De-Contamination

Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.

Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.

Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

☐ **Used as SIL device in a Safety Instrumented System /** *Einsatz als SIL Gerät in Schutzeinrichtungen*

Process data/ *Prozessdaten*

Temperature / *Temperatur* _____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium






	Medium /concentration *Medium /Konzentration*	Identification CAS No.	flammable *entzündlich*	toxic *giftig*	corrosive *ätzend*	harmful/ irritant *gesundheits-schädlich/ reizend*	other * *sonstiges**	harmless *unbedenklich*
Process medium *Medium im Prozess*								
Medium for process cleaning *Medium zur Prozessreinigung*								
Returned part cleaned with *Medium zur Endreinigung*								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* *explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv*

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Description of failure / *Fehlerbeschreibung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

_____

Address / *Adresse*

_____

_____

Phone number of contact person / *Telefon-Nr. Ansprechpartner:*

_____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."

"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

BA424C/07/en/06.09
71085882
Printed in Germany / FM+SGML 6.0 / DT

71085882