Manual

Carbon / Sulphur Analyzer CSi

Translation

ELTRA®

Table of Contents

1 Contact information

Please contact your local representative in the event of problems. You can find the complete list of dealers at www.eltra.com.

Of course you can also contact ELTRA-Germany directly:

ELTRA GmbH
Retsch Allee 1-5
42781 Haan
Germany
Web: www.eltra.com
Email: service@eltra.com

2 Notes on the Manual

This Operating Manual provides technical instructions for the safe operation of the device and contains all necessary information about the topics given in the table of contents. This technical documentation is meant to be a tutorial and a reference. The individual chapters are self-contained.
Knowledge of the relevant chapters (for the respective target groups defined according to areas) is a prerequisite for the safe and correct use of the device.
This Operating Manual contains no repair instructions. In the event of any faults or necessary repair work, please contact your supplier or Eltra GmbH directly.

Amendments

Subject to technical changes.

2.1 Explanations of the Safety Instructions

In this Operating Manual, we give you the following safety warnings
Mortal injury may result from not following these safety warnings. We give you the following warnings and corresponding content.

DANGER D1.0000

Type of danger / personal injury
Source of danger

- Possible consequences if the dangers are not observed.
- **Instructions and information on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:

DANGER

Serious injury may result from not following these safety warnings. We give you the following warnings and corresponding content.

WARNING W1.0000

Type of danger / personal injury
Source of danger

- Possible consequences if the dangers are not observed.
- **Instructions and information on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:

WARNING

Moderate or mild injury may result from not following these safety warnings. We give you the following warnings and corresponding content.

CAUTION C1.0000

Type of danger / personal injury
Source of danger

- Possible consequences if the dangers are not observed.
- **Instructions and information on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:

CAUTION C2.0000

In the event of possible **property damage** we inform you with the word “Instructions” and the corresponding content.

NOTICE N1.0000

Type of property damage
Source of property damage

- Possible consequences if the notices are not observed.
- **Instructions and information on how the property damages are to be avoided.**

We also use the following signal word in the text or in the instructions on action to be taken:

NOTICE

2.2 General Safety Instructions

⚠ CAUTION C3.0005

Risk of explosion or fire
Potentially explosive atmosphere

- On account of its design, the device is not suitable for use in potentially explosive atmospheres.
- **Do not operate the device in a potentially explosive atmosphere.**

⚠ CAUTION C4.0002

Read the manual
Non-observance of the manual

- The non-observance of this manual can result in personal injuries.
- **Read the manual before using the device.**

Target group:
All activities required for correct use are described in this Operating Manual. Any activities that go beyond this may only be performed by authorised electricians who have received in-depth training for this analyzer.

As the operating company, you must ensure that the following applies to the persons working on the analyzer;

- Operating personnel have been made aware of and have understood all safety regulations;
- Operating personnel are familiar when starting work with all handling instructions and regulations that apply to the relevant target group for them;
- Operating personnel have access at all times to the technical documentation of this analyzer;
- New personnel are familiarised with the safe and intended use of the analyzer before starting work on it by means of a verbal introduction by a competent person and using this technical documentation.

Incorrect operation can result in injury and damage to property. You are responsible for your own safety and for that of your employees.
Ensure that no unauthorised persons have access to the analyzer.

⚠ CAUTION C5.0089

Changes to the machine

– Changes to the machine may lead to personal injury.
- **Do not make any change to the analyzer and use spare parts and accessories that have been approved by Eltra exclusively.**

⚠ CAUTION C6.0120

Personal injury
Incorrect repairs

– These operating instructions do not contain any repair instructions .
- **For safety reasons, repairs may only be carried out by the Eltra GmbH or an authorised representative and by qualified service technicians.**

NOTICE N2.0074

Changes to the machine
Improper modifications

– The conformity declared by Eltra GmbH with the European Directives will lose its validity.
– Any warranty claims will be terminated.
- **Do not make any modification to the machine.**
- **Use spare parts and accessories that have been approved by Eltra GmbH exclusively.**

2.3 Explanation of signs and symbols

2.3.1 Signs

Sign	Meaning
•	Instruction
–	Explanation
Name	Software button

2.3.2 Frequently used symbols

Number	Symbol	Reference	Meaning
12			Danger, high voltage, electric shock
13		IEC 60417-5041	Caution, hot surface
14		ISO 7000-0434B	General hazard, see documentation

-		BGV A8 W27	Risk of crushing
			– Caution – heavy object – Caution – unbalanced weight; take care during transport

2.3.3 Back of the device

Symbol	Meaning
Outlet 230V AC max. 500W	Socket label
System Exhaust Outlet	Exhaust outlet label
USB → PC UNI2	Connection UNI2 to PC
USB → PC DevGate	Connection DevGate to PC
See chapter on “Type plate description”	Type plate
See chapter on “Connecting gas hoses”	Gas inlets

3 Packaging, Transport and Installation

3.1 Packaging

The packaging has been adapted to the mode of transport. It complies with the generally applicable packaging guidelines.

3.2 Transport

⚠ CAUTION C7.0107

NOTICE N3.0075

Transport

- Mechanical or electronic components may be damaged.
- **The device must not be bumped, shaken or thrown during transport.**
- **The device must be transported upright**

⚠ CAUTION C8.0078

Falling down of the device

Incorrect installation or insufficient mounting of the analyzer on a means of transport such as a trolley.

The analyzer can also start to slip on a trolley due to obstacles on the ground

- Due to its weight, the device can inflict personal injury if it falls down.
- The analyzer can be damaged if it falls down.
- **The analyzer may be transported well fixed on a means of transport**
- **If the analyzer is placed on a trolley, only the trolley must be pushed, in no case the analyzer itself**
- **All movements must be careful and slow!**

3.3 Intended use

This analyzer was designed for the analysis of mainly steel and other metals. However, a wide variety of materials such as cement, ceramics and soil can also be analyzed.

With restrictions concerning sample weight and accuracy, also coal, rubber, plastics etc. can be analyzed.

Depending on the application, the sample weights, accelerator(s) and settings on the analyzer can significantly influence the accuracy and precision of the measured values.

Use is only permitted in the laboratory by appropriately trained and briefed personnel.
All other applications are prohibited, in particular use in non-industrial areas.

3.4 Conditions for the Installation Site

Requirements regarding the operating conditions:

– For indoor use only.
– Operation up to max. 2,000 m above sea level.
– Ambient temperature of between 5°C and 40°C.
– Maximum relative air humidity < 80 % (at ambient temperatures ≤ 31°C), with linear decrease up to 50% relative air humidity at 40°C, non-condensing.
– A residual current operated device (RCD), and a corresponding fuse (30 mA).

⚠ WARNING

Provide an external fuse when connecting the mains lead to the mains in accordance with the regulations at the installation site.

– Information about the required voltage and frequency of the device can be found on the type plate .
– The data listed must be consistent with the existing power supply system.
– The device may only be connected to the power supply system using the connecting lead supplied.

NOTICE

N4.0000

Electrical connection
Failure to heed the data on the type plate

– Electronic and mechanical components may be damaged.
- **Only connect the device to a power supply system that is consistent with the data on the type plate.**

– Fluctuations of the mains supply voltage up to ± 10 %.
– The device must be operated in accordance with overvoltage category II and pollution category 2, DIN EN 61010-1.
– Industrial environment in accordance with DIN EN 61010-1

3.5 Technical specifications

3.5.1 Electrical data

Voltage definition	~230V ± 10%
Mains frequency	50Hz
Amps	14A
Protection class	1

3.5.2 Type Plate Description

NOTICE

N5.0022

Electrical connection

Failure to observe the values on the type plate

- Electronic and mechanical components may be damaged.
- **Connect the device only to a mains supply matching the values on the type plate.**

Fig. 1: Type plate

1	Device designation
2	Serial number
3	Year of manufacture
4	Voltage definition
5	Amps
6	Manufacturer’s address
7	Item number
8	Mains frequency
9	Protection type
10	Disposal label
11	CE mark

Please quote the device designation (1), the serial number (2) of the device and the item number (7) if you have any queries.

3.6 Pre-installation guide

Following requirements apply, when installing the analyzer:

Carrier gas	Oxygen 99.5% pure; 2 - 4bar (30 - 60psi)
Compressed air	4 – 6bar (60 - 90psi)
Mains power supply	230VAC ±10%, 50/60Hz; 16A fuse

Analyzer dimension	520 x 840 x 750mm (WHD)
Analyzer weight	approx. 150kg

– It is important to install the instrument on a stable place.
– The balance should rest on a vibration free support.

Connections for compressed air:
The tubes supplied together with the analyzer, carry a connector with G¼" inner diameter.

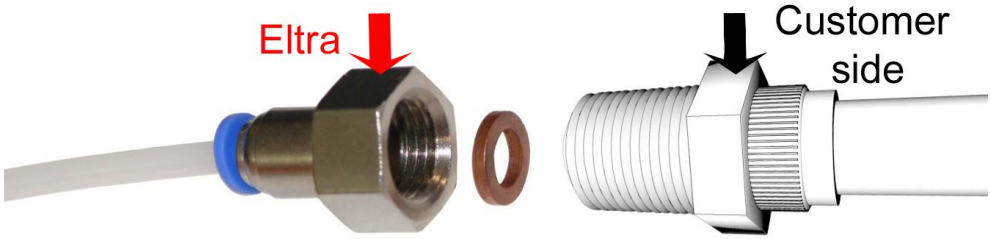


Fig. 2: Compressed air tube

Connections for carrier gas:
The supplied tubes carry a connector with G¼" inner diameter ".

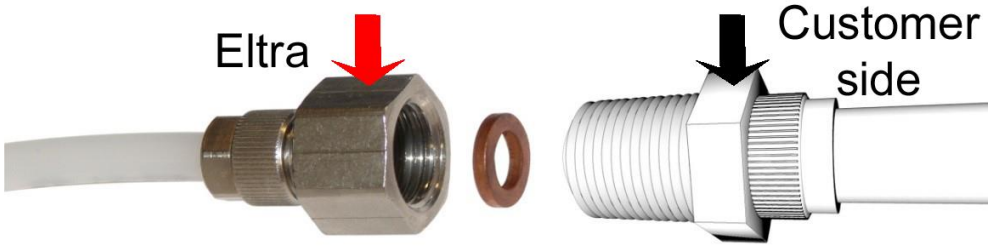


Fig. 3: Carrier gas tube

NOTICE
"**Internet connection:**
For fast online support connect the analyzer PC to the internet."

4 First Commissioning

4.1 Unpacking the analyzer

NOTICE N6.0079

Disposal of the CSi packaging
Please refer to your country's packaging disposal guidelines and, if applicable, your company's packaging guidelines.

The analyzer is despatched in a stable cardboard box wrap, which is standing in a wooden box with foam inlay.
To lift the Analyzer from the packaging, two carrying straps are supplied

- Open the top of the box.

Fig. 4: Top of the box

- At the top, the analyzer is held by a foam cover.

Fig. 5: Foam cover

- Remove the foam cover.

Fig. 6: Removed foam cover

– The Box covers now only loosely the analyzer
- Hold the rand and pull up the whole box.

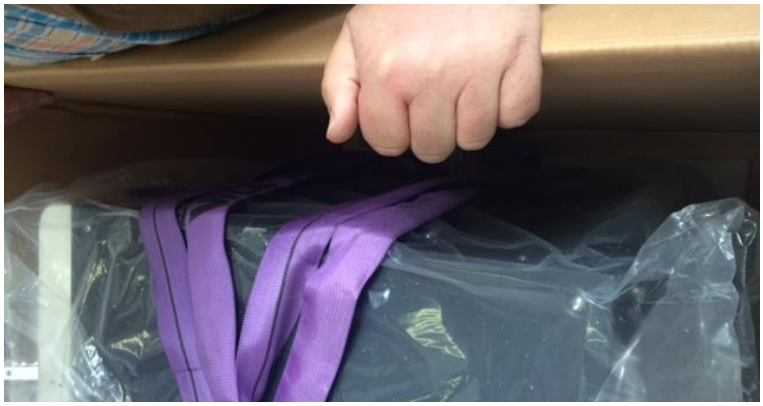


Fig. 7: Pull up the box

– Now the analyzer just stands in the wooden box.

Fig. 8: Analyzer in wooden box

- Use the carrying straps and lift the analyzer with a lifting aid out of the wooden box

NOTICE

The supplied carrying straps cannot slip when lifting the analyzer because they are held in place by 8 feet. See the following figure

Fig. 9: Fixed carrying straps

4.2 Installation of the Device

⚠ CAUTION C9.0078

Falling down of the device

Incorrect installation or insufficient mounting of the analyzer on a means of transport such as a trolley.

The analyzer can also start to slip on a trolley due to obstacles on the ground

- Due to its weight, the device can inflict personal injury if it falls down.
- The analyzer can be damaged if it falls down.
- **The analyzer may be transported well fixed on a means of transport**
- **If the analyzer is placed on a trolley, only the trolley must be pushed, in no case the analyzer itself**
- **All movements must be careful and slow!**

⚠ CAUTION C10.0092

Device falling down

Incorrect erection or inadequate working space

- Due to its weight, the device can cause injuries if it falls down.
- **Only operate the device on a sufficiently large, strong, non-slip and stable working area.**
- **Ensure that all feet of the device are standing securely.**

⚠ WARNING W2.0021

Fire hazard / Risk of burns

Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material
- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

NOTICE N7.0002

Setting up the device

Disconnecting the device from the mains

- A separation of the device from the mains must be possible at any time.
- **Set up the device in such a way, that the connection for the power cable is always easily accessible.**

The construction of the support must safely withstand the weight of the analyzer (150 kg). The surface of the desk must be non-slip and fire resistant. Take care to position the device so that the fans on the back and underneath are not blocked. The balance should likewise be placed on a vibration-free base. An example of installation is shown below:

Fig. 10: Installation example

NOTICE

Under no circumstances may the device be placed on a moving desk, such as a trolley!

NOTICE

Under no circumstances may the device be exposed to direct sunlight!
Avoid installation sites where there is a draught from air conditioning systems or from open windows or doors.

NOTICE

When you connect the supply lines, it is important that the analyzer is on the end position. Only in this way can the lengths of the lines and hoses be suitably adjusted. During initial installation, please follow the steps in the following chapter!

4.3 Connecting the analyzer

WARNING

W3.0002

Danger to life through electric shock
Damaged power cable

- An electric shock can cause burns, cardiac arrhythmia, respiratory arrest, as well as cardiac arrest.
- **Never use a damaged power cable to connect the device to the mains!**
- **Check the power cable and the plug for any damage before use.**

Since the infrared cell requires about 1 hour to reach a stable operation temperature, it is advisable to connect the analyzer to the mains power first immediately switch it on before further installation work is carried out.
This waiting time is only necessary when switching on the analyzer from cold condition. It is then normally not switched completely off, in order to always be at constant operation temperature. During long work breaks, the analyzer is on stand-by, which is on position 1 of the mains power switch.

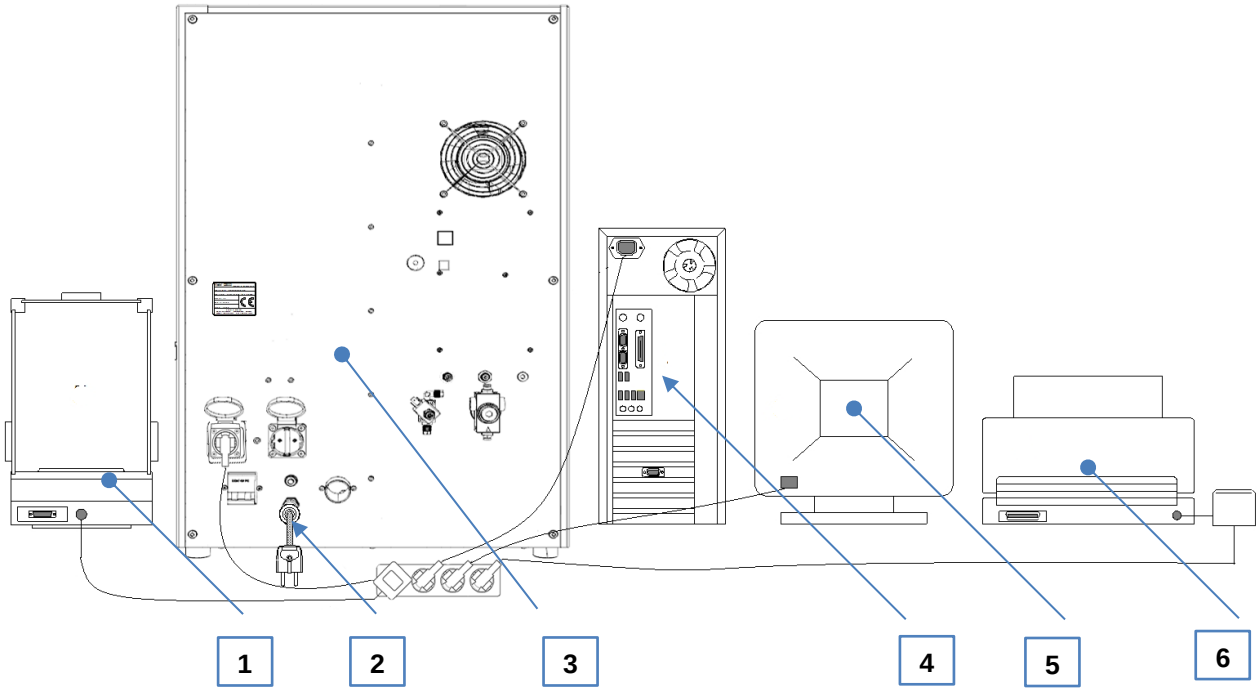


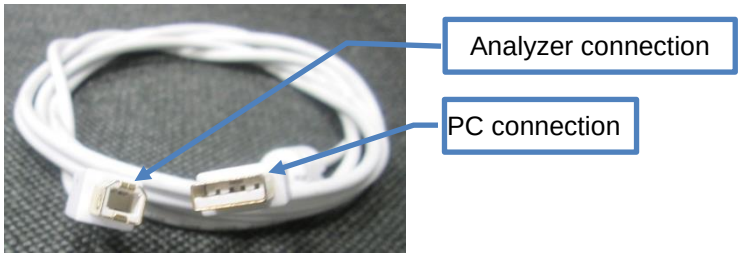
Fig. 1: Mains power connection - rear view

1	Balance
2	Analyzer mains plug
3	Analyzer
4	Quad power socket
5	Computer
6	Monitor

First connect the analyzer to the mains power and switch it on to position 1 in order to win time. The power switch is located on the front panel in the low right hand corner. Set to position 1. The reason why to first switch on the analyzer is for the infrared detectors to have time to stabilize their temperature while cable connections and software start are made.

4.3.1 Connecting the data cable

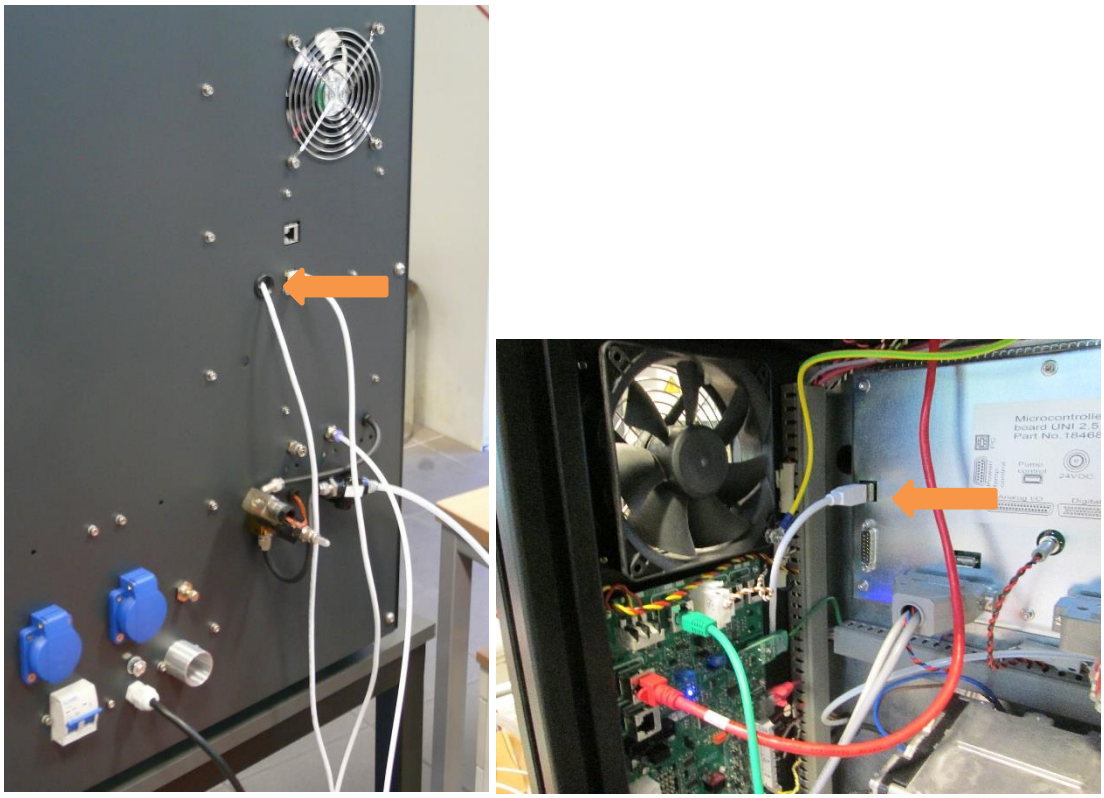
The following figure shows the data cables provided



2x data cables

Fig. 11: Supplied data cables

- Connect the data cables: to do this, open the left-hand side of the device. Slide the USB port of the data cable through the designated hole into the device from behind and connect it to the Uniboard (see the following figures).



Hole for data cable

Connection for Uniboard

Fig. 12: Data cable connection

- Connect the USB port on the second data cable to the DevGate that is responsible for the electronics control. The port can be found on the back of the analyzer; see the figure below.

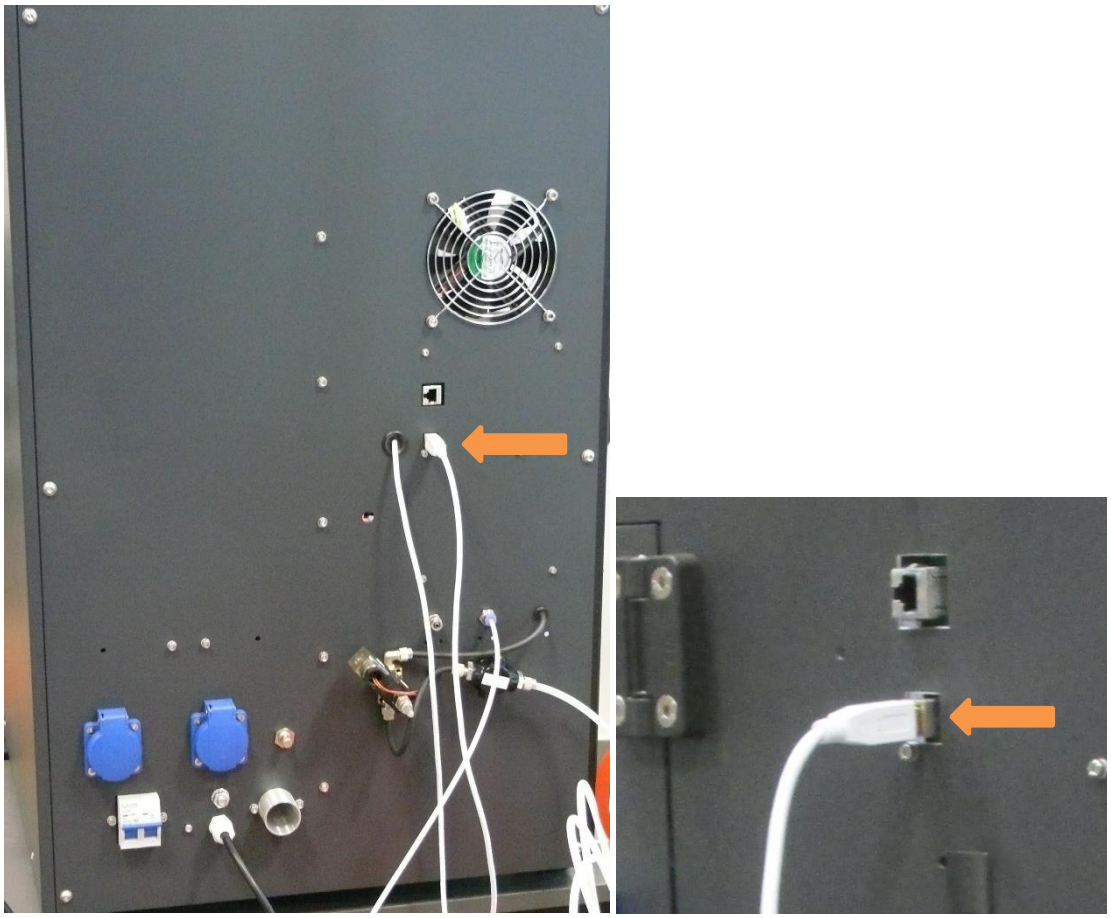


Fig. 13: DevGate connection

4.3.2 Connecting the gas hoses

WARNING W4.0032

Analyzer can release harmful or toxic gases.
Samples are exposed to higher temperatures. Depending on the analyzer these temperatures can reach up to 3000 degree C. Heated samples can decompose gases like HF or H2S or can form gases like NOx or SO2. These gases can leave the analyzer through the furnace or the gas outlet.

- Released gases can harm the operator of the analyzer or the environment.
- Corrosive gases can damage the analyser.
- Carrier gas oxygen can cause an extreme intensive combustion reaction. As a consequence, harmful or toxic gaseous interstage products can be released.
- Not adequate sample mass increases the risk of releasing toxic or harmful gases.

- **Evaluate the hazard potential of an analysis with your security officer in your company.**
- **Realize suitable safety procedures for protection of laboratory staff, environment and analyzer.**

The following list illustrates possible safety procedures in an exemplary way. Due to the hazard potential of the sample the list of suitable procedures can be extended or shortened:

- **Connect the gas outlet of the analyzer to a ventilation.**
- **Place the whole analyzer in a suitable ventilation.**
- **Use a halogen trap or other suitable chemicals to absorb harmful substances.**
- **Wear a suitable personal protection equipment.**

The following figure shows the gas hoses supplied.

Compressed air hose

Carrier gas hose

Fig. 14: Gas hoses supplied

The hoses for the supply of carrier gas have an external diameter of 6 mm.
The hose for the supply of carrier gas has an external diameter of 4 mm.
These hoses are supplied with connectors with a G¼" internal thread.

- Connect the compressed air and carrier air. The connections for these can be found at the back of the analyzer: see the figure below. Only use the hoses provided.
- Push the hose for the compressed air supply into connection 1, as shown in the figure below.

- Connect the carrier air to connection 2 on the pressure controller. To do this, unscrew the cap nut from the connector. Slide the cap nut over the hose for the carrier gas supply. Connect the hose to connector 2 and screw the cap nut tight.

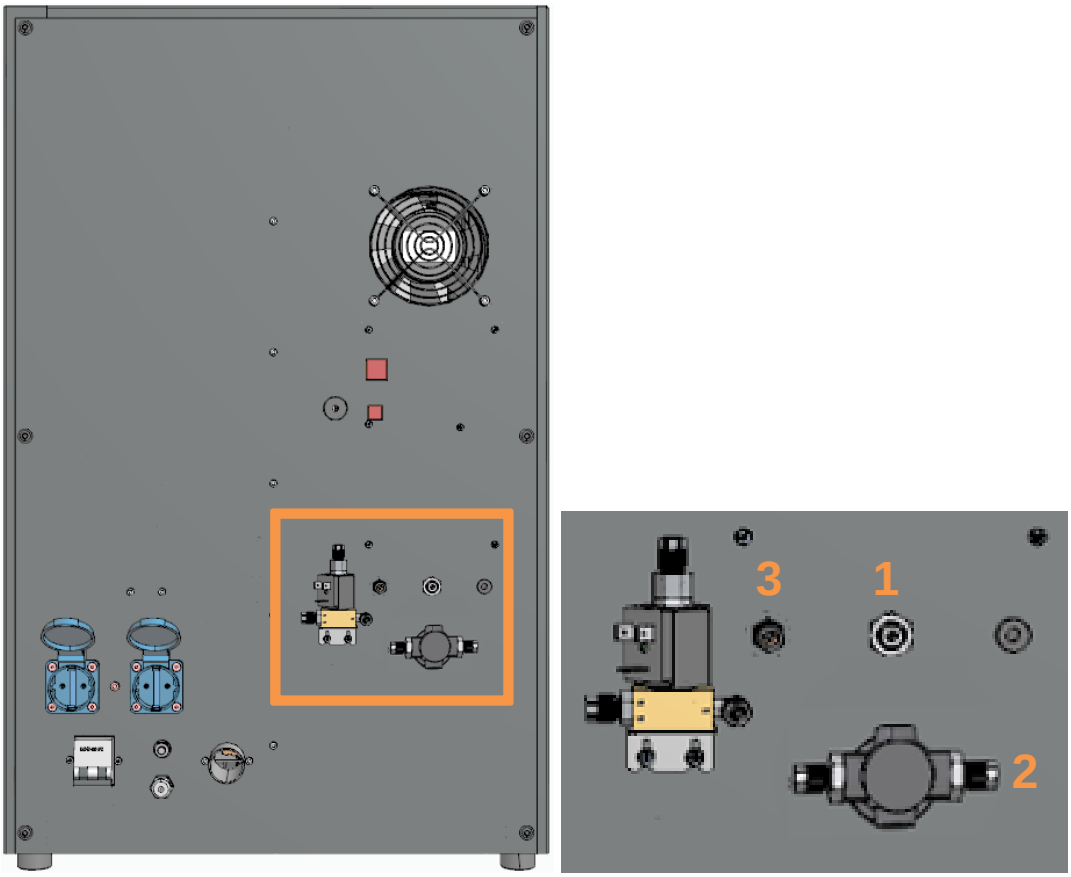


Fig. 15: Gas connections

NOTICE

Please comply with the specified direction of flow on the pressure controller.

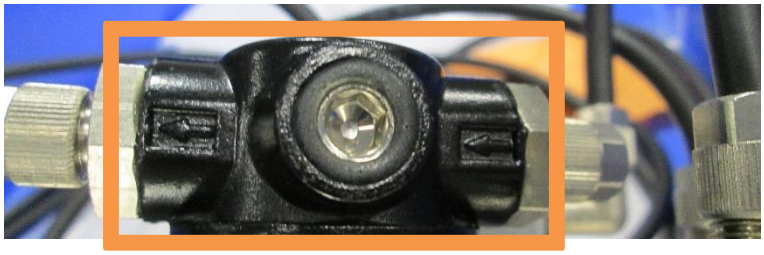


Fig. 16: Direction of flow on pressure controller

1	Compressed air inlet, 3-6 bar (45-90 psi), oil-free
2	Oxygen inlet, 2-4 bar (30-60 psi), degree of purity 99.5%
3	Exhaust air connection

- If present, connect the analyzer to the exhaust hose for the disposal of the exhaust gas outside, see Figure No. 3 showing the “Gas connections”.

4.3.3 Connecting the PC and scales

- Now set up the PC and balance; to do this, see the “Installation example” in Figure 5
- Connect the two data cables going from the device to the PC.
- Connect the balance cable.

4.3.4 Switching the analyzer on for the first time

- Check whether all connections, such as gas connections, have been securely connected.
- Connect all equipment to the power supply.
- Switch the analyzer on by turning the mains switch on the front of the device to 1.
- Turn on the carrier gas and compressed gas supply. Check whether the compressed air is set to 3-6 bar and the carrier gas to 2-4 bar. This is done at the gas source, e.g. on the pressure reducer on the gas cylinder.

NOTICE

During initial installation, it takes around 1 hour for the device to completely reach operating temperature so that a measurement may be taken.

4.4 Initial filling of the reagent tubes

⚠ CAUTION

C11.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.

- **Use heat protecting gloves.**

⚠ CAUTION

C12.0095

Injuries in the form of cuts and other personal injuries

Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged glasware and glass splitters.

- **Replace damaged glassware / reagent tubes**
- **Do not touch glass splitters with your hands.**

⚠ CAUTION

C13.0081

Danger of bursting

– Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.

- **Before installing the new reagent tubes, check if they are damaged.**
- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**

CAUTION

C14.0090

Risk of injury to eyes
Chemicals

- When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

WARNING

W5.0017

Danger of toxication and personal injuries

- Some chemicals may cause a fatal toxication or dangerous skin corrosion.
- **Refer to the material safety data sheet of the used substances.**
- **Never eat or drink close to the chemical substances.**

WARNING

W6.0022

Burning of the skin, eyes and respiratory system.
Corrosive substances:

- Corrosive substances can cause burning of the skin, eyes and respiratory system.
- **Refer to the material safety data sheet for the substance being used.**
- **Always wear suitable clothing, including protective gloves and eye protection.**

The reagent tubes/filters specified in the following table must be filled or installed in order to guarantee the correct functioning of the analyzer. The necessary steps and fillings are shown in the chapter on maintenance:

Reagent tube	More information in chapter
Moisture filter	8.3.6
Particle filter	8.3.5
Carrier gas preliminary purification	8.3.3
Cellulose filter	8.3.4
Catalyser	8.3.2.
Oxygen purification furnace filling (optional)	8.3.7

5 Analysis

5.1 Working procedure

⚠ WARNING W7.0032

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The following list illustrates possible safety procedures in an exemplary way. Due to the hazard potential of the sample the list of suitable procedures can be extended or shortened:

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- **Place the whole analyzer in a suitable ventilation.**
- **Use a halogen trap or other suitable chemicals to absorb harmful substances.**
- **Wear a suitable personal protection equipment.**

WARNING

W8.0021

Fire hazard / Risk of burns

Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material
- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

CAUTION

C15.0093a

Hot crucibles / Boats (sample carrier)

- After analysis the sample carrier can be extremely hot and can cause personal injury as well as fire when it gets in contact with flammable surfaces.
- **Always use suitable tongues to transport used crucibles and boats**
- **If possible increase cooling down time for the sample carrier before it is given to waste or is cleaned. Depending on the analyser the software provides different settings:**
- **Adapt the "Post waiting time" so that the crucible can cool down sufficiently.**
- **Open furnace at suitable temperatures.**
- **Take care that no flammable materials are situated below the furnace opening.**

The CSi has primarily been developed to analyse steel and other metals, although many other materials such as cement, ceramic and soil can also be analysed using this device. With certain limitations regarding sample weight and accuracy, it is furthermore possible to analyse coal, rubber, plastics etc. The sample weight, the additives and the sensitivity of the analyzer depend on the properties of the respective sample material during combustion.

The analysis of steel is described below by way of example:

- Switch the PC on.
- Ensure that the compressed air and oxygen supply are switched on.
- Switch the mains switch on the analyzer to Position 2.
- Open the ELEMENTS software and login.

NOTICE

Refer to "Login" in the software instructions for further information.

- Check whether the right profile has been set. To do this, press F9 repeatedly until the following window opens and check whether the CSi profile has been selected.

NOTICE

For further information, refer to the software instructions.

Fig. 17: Checking the profile

- Open the applications window by pressing the F9 button, and select the preinstalled methods.

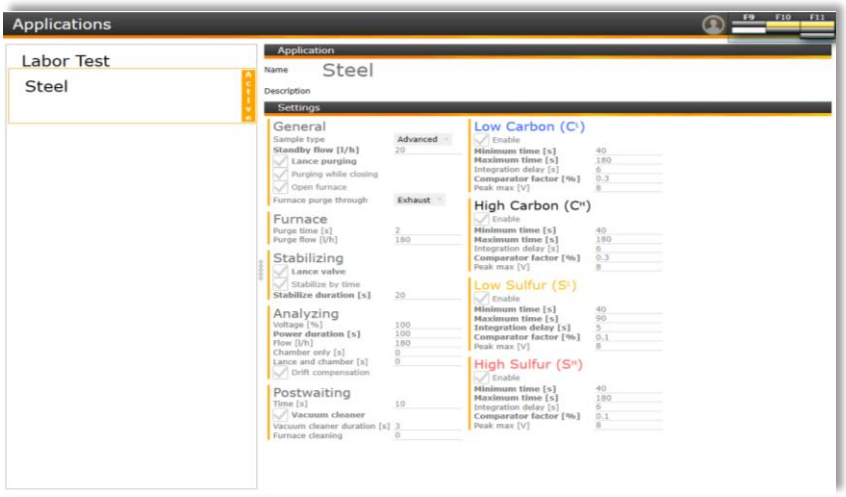


Fig. 18: Application window

- Open the “Analyzer status” window by repeatedly pressing the F11 button, and check the settings.

Parameter	Permissible working range
Furnace temperature	30-50 °C
Catalyst furnace temperature	300-600 °C
Carrier gas pressure	2-4 bar
Analysis flow	0-10 L/h in standby; 180L/h during analysis

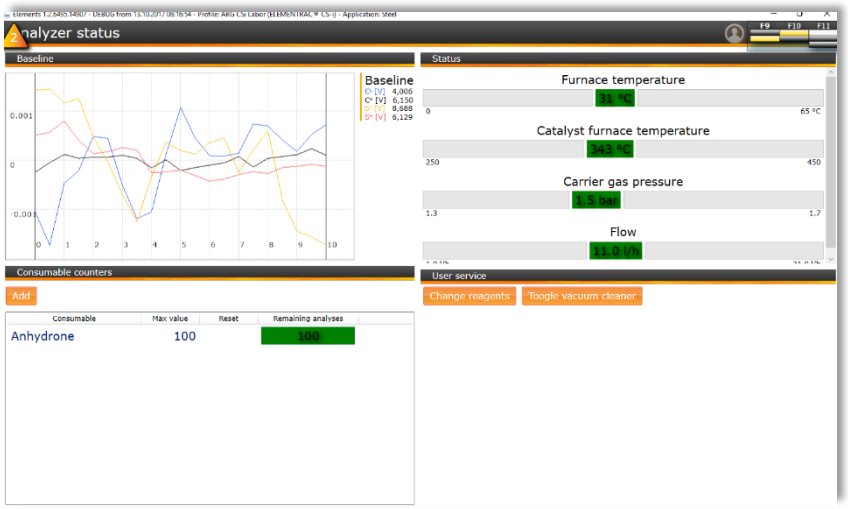


Fig. 19: Analyzer status, standby window

- Open the “Analysis & results” window by repeatedly pressing the F10 button.

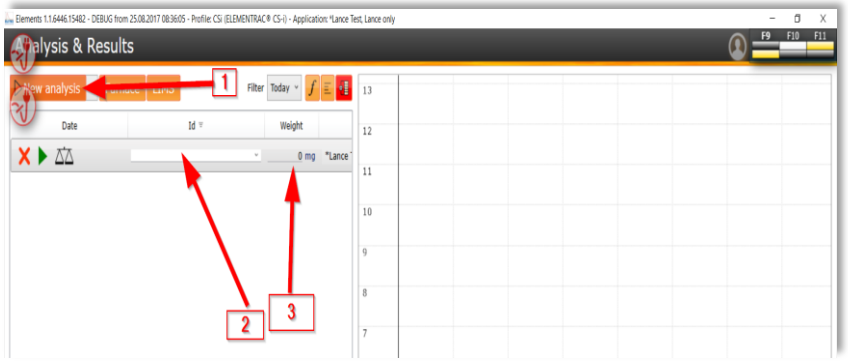


Fig. 20:

- In the tab (1), select a new analysis by clicking with the left mouse button, and enter the sample name in box (2) and the sample weight in box (3).
- To determine the sample weight, place a ceramic crucible (e.g. ELTRA 90149) on the analytical balance, tare the weight and fill with the sample (e.g. 500 mg of steel calibration standard 92400-3030).
- Enter the sample weight by hand into box (3) or accept the sample weight from the balance by pressing the F 4 button.

NOTICE

Never touch the crucible with your fingers. Always use clean tongs. Refer to the chapter on the “Correct use of the crucibles” for further information.

- Then add 1.5 – 1.7 g of tungsten to the crucible (corresponds to around a full measuring spoon (23113).

NOTICE

The weight of the additives is not taken into consideration for the sample weight.

- The crucible is placed on the pedestal.

Fig. 21: Placing the crucible on the pedestal

- Start the analysis. This is done by pressing the F5 button or clicking on the green arrow.

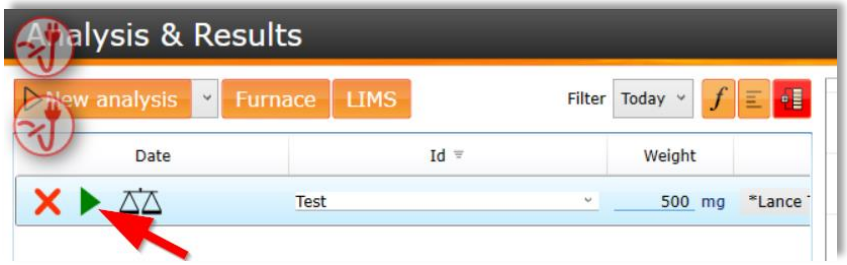


Fig. 22:

- At the end of the analysis process (for details see the chapter on the analysis process), the measured concentrations of the sample are read out in the software and the furnace with the hot crucible opens.

NOTICE

Never move the mains switch from Position 2 to Position 1 during the analysis cycle.

5.2 Analysis process

⚠ WARNING W9.0019

Hand injury

Putting your hand into the closing furnace.

- Accidental contact with the closing furnace can lead to hand injuries, e.g. crushing of fingers.

- **Never reach into the closing furnace.**

⚠ CAUTION C16.0093a

Hot crucibles / Boats (sample carrier)

- After analysis the sample carrier can be extremely hot and can cause personal injury as well as fire when it gets in contact with flammable surfaces.

- **Always use suitable tongues to transport used crucibles and boats**
- **If possible increase cooling down time for the sample carrier before it is given to waste or is cleaned. Depending on the analyser the software provides different settings:**
- **Adapt the "Post waiting time" so that the crucible can cool down sufficiently.**
- **Open furnace at suitable temperatures.**
- **Take care that no flammable materials are situated below the furnace opening.**

The analysis process can be divided into five phases.
The following sequence is activated by clicking on "Start analysis":

1st phase – initialisation: (approx. 2-3 seconds)
The furnace is closed, and the oxygen lance and furnace chamber are briefly purged with oxygen.

2nd phase - purging: (approx. 5 seconds)
While the furnace is closed, the furnace chamber is purged through the chamber and lance with oxygen and the gases are extracted via a valve without passing the infrared measuring cell. This removes any impurities from the previous analysis.

3rd phase - stabilising: (approx. 10 seconds)
During the stabilising process, the oxygen flows through the furnace, the catalyser module and the IR cells to stabilise the measuring cells.

4th phase – analysis: (approx. 30 -40 seconds)
The induction furnace is switched on and the sample is melted in the oxygen flow at temperatures of over 2200^0C. The gases created by this are purged through the system by carrier gas at approx. 180l/h (depending on the application).
The concentration of the gas is then measured by up to four detector modules. The gas then leaves the analyzer through the discharge valve.

5th phase – additional waiting time: (approx. 10 seconds)
Temporal delay (s) at the end of the analysis before the furnace is opened. This is designed to prevent any red glowing crucible being taken out of the furnace to ensure the safety of the user.

Phases 2-5 have defined times and are specified by the user in the software under "Application".
Please refer to the "**Applications**" chapter in the software instructions.

5.3 Correct handling of the crucibles

⚠ WARNING

W10.0021

Fire hazard / Risk of burns
Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material
- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

– Due to the high risk of injuries such as burns / crushing of fingers or hands, please always use the crucible pliers supplied (order number: 90145) when working with the crucible; see the following figure.

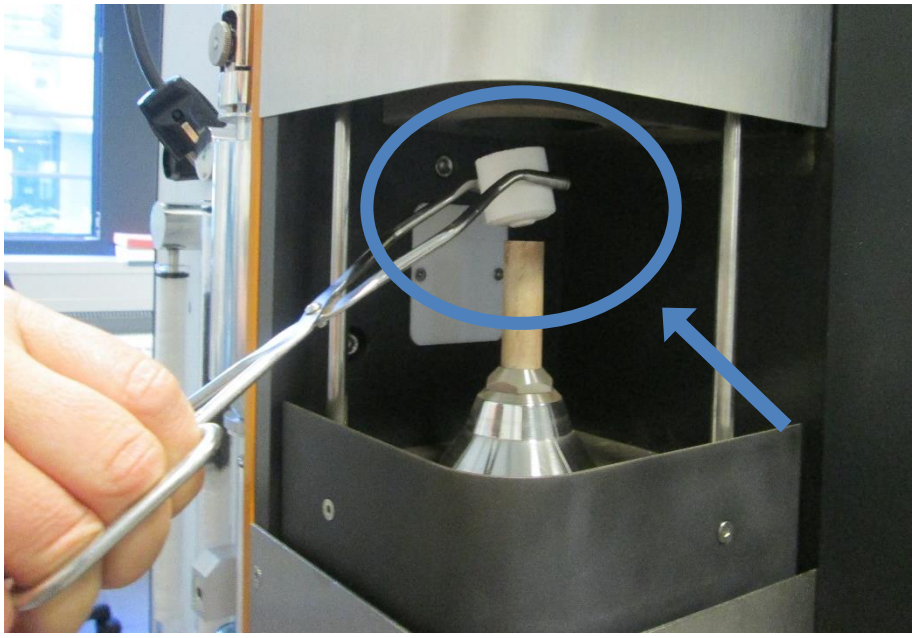


Fig. 23: Working with the crucibles

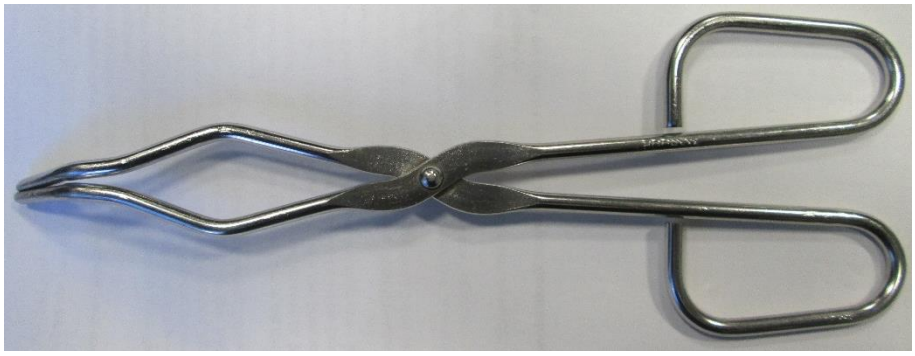


Fig. 24: Crucible pliers, order number: 90145

– Please place the used crucibles in a flameproof bucket. Suitable buckets are ELTRA 90146 or 88400-0509. Used crucibles heat up the bucket. Please make sure that the bucket is placed on a heat-resistance surface.
– You can dispose of the cooled crucibles with the residual waste . . However please note that the crucibles contain the melted sample after the analysis. The relevant local regulations and provisions apply to these (e.g. the safety data sheet).

5.4 Crucibles preheating, optional

⚠ CAUTION C17.0096

Eye injury
Hot combustion tube.

– Eye damage.
- **Avoid looking directly into the hot combustion tube. For eye protection use the supplied protective glass.**

⚠ CAUTION C18.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

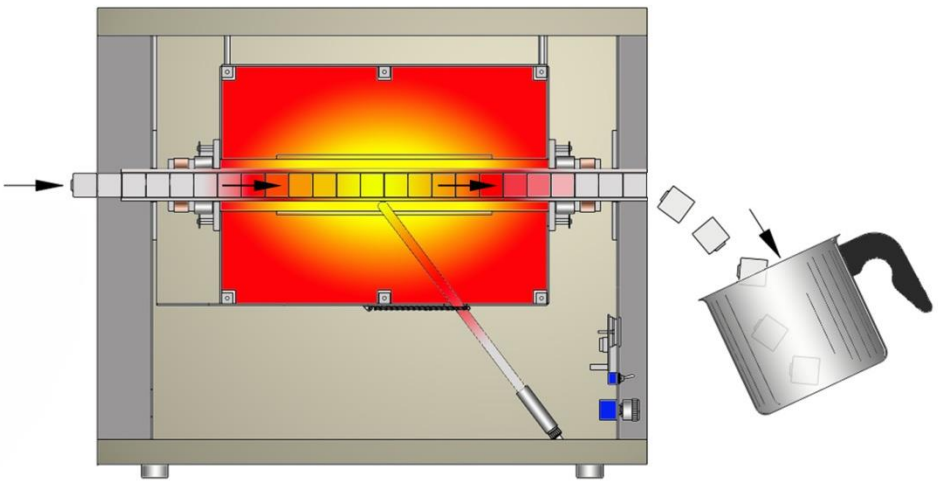


Fig. 25: Preheating the sample crucible

The furnace illustrated above is used to preheat the sample crucible. It is available as an optional accessory.
The preheating of the crucibles is recommended when analysing samples with a low carbon or sulphur concentration (<1000 ppm).
The crucibles contain varying amounts of impurities from carbon that can have a significant impact on the reproducibility of measurements in the low carbon range. By preheating the crucibles (for at least 20 minutes at 1000 °C), the impurities are removed, and they can then also be used for measurements in the lowest ppm range (e.g. 6 ppm carbon).

5.5 Operating the preheating furnace (optional)

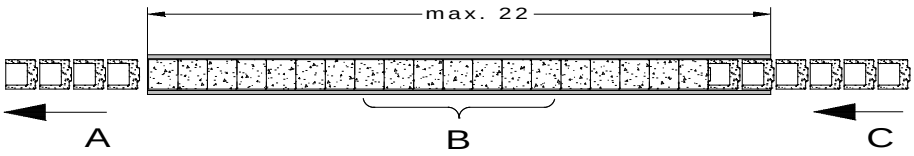


Fig. 26: Operating the preheating furnace

The ELTRA crucible preheating furnace consists of a heated horizontal ceramic tube in which successive ceramic crucibles (e.g. ELTRA 90149) can be preheated.

NOTICE

Never add more than four crucibles to the furnace at any one time, otherwise the combustion tube can be damaged by the temperature shock caused by the cold crucibles inserted.

Set the temperature to 1,000 °C, whereby (B) is the actively heated zone. When the target temperature is reached, you can add the first 4 crucibles; a further 4 crucibles can be added via the (C) feed after a waiting period of five minutes. This process can be repeated; the furnace has room for up to 22 crucibles.
When new crucibles are placed in the furnace for preheating, the corresponding number of preheated crucibles falls out at the other end (A) of the flue, and after a brief cooling period, these can be used for analysis in the ELEMENTRAC CSi.

5.6 Applications

The Elementrac CSi can use up to four measuring cells for the analysis of carbon and sulfur. These 4 measuring cells are identified by the element to be measured and the intended measuring range:
LC – low carbon measuring range
HC – high carbon measuring range
LS – low sulphur measuring range
HS – high sulphur measuring range

In general, the following application settings can be recommended:
A) Ferrous or General metallic samples
(e.g., steel, pure iron, pig iron, nickel)
500 mg sample weight and 1.5g (+ -0.2g) tungsten supplement (ELTRA 90220).

B) non-metallic samples
50-250 mg sample weight, and 0.7g (+ - 0.1g) iron supplement (ELTRA 90260 or 88600-0013)

and 1.5g (+ -0.2g) tungsten supplement (ELTRA 90220).

NOTICE

The following list summarizes observations and recommendations of the last years to give an application recommendation for as many sample matrices as possible. This information has been compiled with great care, whereby a deviation from these recommendations in defined cases does not make sense. For application-related questions or uncertainties, please contact the local ELTRA contact person.

Material/ Analysis time (s)	Sample + Accelerators	Calibration		Typical results
Aluminium 50s	1.5g ± 0.2g Tungsten 700mg ± 50mg Sample 0.7g ± 0.1g Nickel	**LC**	0.1% C Steel	60ppm C
		HC	2.0% C Steel	3% C
		LS	0.1% S Steel	0.2% S
		HS		
Ash 50s	1.6g ± 0.2g Tungsten 120mg ± 50mg Sample 0.5g ± 0.1g Iron	**LC**	0.1% C Steel	
		HC	2.5% C Steel	3.5% C
		LS	0.1% S Steel	
		HS		
$BaCO_3$ 50s	1.7g ± 0.2g Tungsten 110mg ± 30mg Sample 0.8g ± 0.2g Iron	**LC**		
		HC	6.08% C $BaCO_3$	6.08% C
		LS		
		HS		
$BaSO_4$ 50s	1.0g ± 0.2g Tungsten 200mg ± 100mg Sample 1.0g ± 0.2g Iron	**LC**		
		HC		
		LS		
		HS	13.7 %S $BaSO_4$	13.7% S
Lead pieces 100s Comparator level =1	2.5g ± 0.2g Tungsten 2.0g ± 0.1g Sample	**LC**	0.1% Steel	60ppm C
		HC		
		LS	0.1% S Steel	100ppm S
		HS		
Lead powder 100s Comparator level =1	2.5g ± 0.2g Tungsten 800mg ± 100g Sample	**LC**	0.1% Steel	60ppm C
		HC		
		LS	0.1% S Steel	100ppm S
		HS		
Soil 60s	1.8g ± 0.2g Tungsten 250mg ± 50mg Sample 0.7g ± 0.1g Iron	**LC**	0.048% C Steel	0.03% C
		HC	1.03% C Steel	3.0% C
		LS	0.13% S Cast iron	1.0% S
		HS	0.336% S Steel	2.0% S
$CaCO_3$ 50s	1.7g ± 0.2g Tungsten 110mg ± 30mg Sample 0.8g ± 0.2g Iron	**LC**		
		HC	12% C $CaCO_3$	12% C
		LS		
		HS		
CaO 60s	1.7g ± 0.1g Tungsten 370mg ± 20mg Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.33% C Steel	0.192% C
		LS	0.13% S Cast iron	0.017% S
		HS	0.336% S Steel	
Cast iron	1.2g ± 0.2g Tungsten	**LC**		

50s	400mg ± 100mg Sample 0.3g ± 0.1g Iron	**HC**	1.33% C Steel	0.192% C
		LS	3.0% S Cast iron	0.017% S
		HS	0.1% S Cast iron	
Ceramics 60s	2.2g ± 0.2g Tungsten 150mg ± 50mg Sample 0.7g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	5.98% C
		LS	0.103% S	
		HS	0.336% S Cast iron	2.57% S
Cement 60s	0.8g ± 0.1g Tungsten 200mg ± 50mg Sample 0.8g ± 0.1g iron	**LC**		
		HC	12% C $CaCO_3$	
		LS		
		HS	13.7% S $BaSO_4$	
Cement 60s	200mg ± 50mg Sample 1.1g ± 0.1g Iron	**LC**	1% C Cement	
		HC	2% C Cement	
		LS	1% S Cement	
		HS		
Chrome 70s	1.5g ± 0.2g Tungsten 200mg ± 50mg Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	0.003% C
		HC	1.33% C Cast iron	
		LS	0.13% S Cast iron	0.001 %
		HS		
Chrome oxide 50s	1.5 ± 0.2g Tungsten 220mg ± 50mg Sample 0.6g ± 0.1g Iron	**LC**	0.1% C Steel	0.02% C
		HC		
		LS	0.1% S	0.025% S
		HS		
Limestone 60s	1.8 ± 0.1g Tungsten 250mg ± 50mg Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.3% C Steel	1.5% C
		LS	0.13% S	0.11% S
		HS		
Cobalt 50s	1.8 ± 0.2g Tungsten 350mg ± 50mg Sample 0.3g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.3% C Steel	1.5% C
		LS	0.13% S	0.11% S
		HS		
Coal and coke 50s	1.5 ± 0.2g Tungsten 50mg ± 10mg Sample 0.5g ± 0.1g Iron	**LC**		
		HC	3.0% C Cast ironl	70% C
		LS	0.1% S Steel	5% S
		HS		
Copper swarfs Min. 60s Max. 90s Power: 4,5V Comp.level: 30mV	5g Sample	**LC**		
		HC		
		LS	15ppm S Copper	10ppm S
		HS		
Copper pin Min 60s Max. 90s Power: 4,5V Comp.level: 30mV	2.0g ± 0.2g Tungsten 1.0g - 2.0g Sample 0.1g ± 0.01g Iron	**LC**		
		HC		
		LS	0.1% S Steel	10ppm S
		HS		
Copper pieces Min. 60s Max. 90s	5g Sample (max. 1g/piece)	**LC**		
		HC		
		LS	0,1% S Steel	10ppm S

Power: 4,5V Comp.level: 30mV		**HS**		
Cu-Ni 50s	2.0g ± 0.2g Tungsten 0.7g ± 0.1g Sample	**LC**	0.048% C Steel	0.036% C
		HC	1.03% C Steel	
		LS	0.1% S Steel	40ppm S
		HS		
Nickel 50s	2.0g ± 0.2g Tungsten 0.8g ± 0.1g Sample 0.8g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC	1.03% C Steel	
		LS	0.1% S Steel	17ppm S
		HS		
Fe-Cr 50s	2.5g ± 0.2g Tungsten 450mg ± 50mg Sample 0.2g ± 0.1g Iron	**LC**	0.1% C Steel	0.2% C
		HC	1.03% C Steel	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Fe-Mn Fe-Mo 50s	1.5g ± 0.2g Tungsten 250mg ± 50mg Sample 0.4g ± 0.1g Iron	**LC**	0.1% C Steel	0.2% C
		HC	3.0% C Cast iron	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Fe-Ni 50s	1.7g ± 0.2g Tungsten 700mg ± 100mg Sample	**LC**	0.1% C Steel	0.2% C
		HC	3.0% C Cast iron	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Fe-Si 50s	1.5g ± 0.2g Tungsten 250mg ± 50mg Sample 0.9g ± 0.1g Iron	**LC**	0.1% C Steel	0.2% C
		HC	3.0% C Cast iron	6.0% C
		LS	0.1% S Steel	0.3% S
		HS		
Fly ash 60s	2.2g ± 0.1g Tungsten 100mg ± 20mg Sample 0.3g ± 0.05g Iron	**LC**	0.048% C Steel	
		HC	6.08% C $BaCO_3$	10% C
		LS	0.13% S Cast iron	0.3% S
		HS		
Gypsum 60s	0.8g ± 0.1g Tungsten 200mg ± 50mg Sample 0.8g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	
		LS		
		HS	13.7% S $BaSO_4$	18% S
Ores 60s	1.0g ± 0.2g Tungsten 130mg ± 30mg Sample 1.0g ± 0.2g Iron	**LC**		
		HC	12% C $CaCO_3$	10% C
		LS	0.1% S Steel	≈3% S
		HS	13.7% S $BaSO_4$	30% S
Iron ores 60s	2.0g ± 0.2g Tungsten 250mg ± 50mg Sample 0.5g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	10% C
		LS	0.1% S Steel	≈3% S
		HS	13.7% S $BaSO_4$	30% S
Rock sample 60s	2.2g ± 0.2g Tungsten 150mg ± 50mg Sample 0.7g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	5.98% C
		LS	0.103% S Steel	
		HS	0.336% S Steel	2.57% S
Rubber 60s	1.5g ± 0.2g Tungsten 40mg ± 10mg Sample	**LC**		
		HC	3.0% C Cast iron	60% C

	0.5g ± 0.1g Iron	**LS**	0.1% S Steel	1.9% S
		HS		
Silicon 60s	1.7g ± 0.2g Tungsten 80mg ± 20mg Sample 0.4g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	
		LS	0.1% S Steel	0.02% S
		HS		
Silicon Carbide 70s	2.0g ± 0.2g Tungsten 60mg ± 10mg Sample 0.7g ± 0.1g Iron	**LC**		
		HC	12% C $CaCO_3$	30% C
		LS	0.1% S Steel	0.02% S
		HS		
Slag 60s	1.0g ± 0.2g Tungsten 500mg ± 100mg Sample 1.0g ± 0.2g Iron	**LC**	0.1% C Steel	
		HC	2.0% C Cast iron	
		LS	0.1% S Steel	0.8% S
		HS		
Steel 50s	1.5g ± 0.2g Tungsten 500mg ± 100mg Sample	**LC**	0.1% C Steel	0.1% C
		HC	3.0% C Cast iron	6% C
		LS	0.1% S Steel	0.3% S
		HS		
Titanium 50s	1.4g ± 0.2g Tungsten 500mg ± 100mg Sample 0.6g ± 0.1g Iron	**LC**	0.1 %C Steel	0.016% C
		HC		
		LS	0.1% S Steel	10ppm S
		HS		
Titanium oxide 60s	2.2g ± 0.2g Tungsten 300mg ± 50mg Sample 0.6g ± 0.1g Iron	**LC**	0.048% C Steel	
		HC		
		LS	0.013% S Cast iron	23ppm S
		HS		
Titanium oxide 60s	2.0g ± 0.2g Tungsten 220mg ± 20mg Sample	**LC**	0.048% C Steel	0.230% C
		HC		
		LS		
		HS		
Tungsten carbide 70s	1.7g ± 0.2g Tungsten 200mg ± 50mg Sample 0.6g ± 0.1g Iron	**LC**		
		HC	6.14% C WC	6.14% C
		LS		
		HS		
Uranium 50s	1.0g ± 0.1g Tungsten 800mg ± 100mg Sample 0.5g ± 0.1g Iron	**LC**	0.1% C Steel	0.50% C
		HC		
		LS	0.1% S Steel	0.07% S
		HS		

5.7 Work breaks

Work breaks, e.g. during lunch breaks, the mains switch remains on position 2. During longer interruptions, e.g. after finishing work for the day, the mains switch is set to position 1 (standby). The analyzer's thermostatic control is then working and no long warm-up time is needed, when re-starting the analyzer. The energy consumption and wear are negligible on standby.
The mains switch is set to pos.2 for about 10-15 minutes before starting the first analysis. Air and any moisture which has entered the analyzer are purged by the oxygen flow. The minor influence which the oxygen flow has on the temperature of the infrared cell is compensated by the thermostatic control. The analyzer is designed for long term use, so that no damage results.

The furnace should always be kept closed during work breaks, so that no moisture from the environmental air can enter the furnace area. Moisture on the inner furnace surface an mainly in the dust filter will bound SO_2 so that the first analyses after long break with open furnace will give low sulfur results for the first few analyses, especially when the sample contains very low sulfur. Moisture from the dust filter can also disturb the base line of the sulfur range.
The furnace should be opened only while replacing crucibles. All the rest of the time it should remain closed.
The furnace remains open only when the analyzer is completely switched off. When the mains switch is on zero, for safety reasons the crucible lift is down.

6 Function description

6.1 Measurement principle and chemical reactions

The ELEMENTRAC CSi is a combustion analyzer that determines the chemical elements of carbon and sulphur through inductive combustion with subsequent measurement in infrared measuring cells.
The measurement of carbon and sulphur can be divided into various individual processes, in which every component of the ELEMENTRAC CSi fulfils a specific task.

The individual processes (see Fig. 23) are as follows:
– Preliminary purification of gas
– Combustion
– Filtering of the combustion gases
– Measurement of sulphur
– Oxidation and removal of sulphur from the combustion gas
– Measurement of carbon
– Presentation and calculation of the results in the software

Preliminary purification of gas:
For combustion of the sample, the ELEMTRAC CSi requires pure oxygen that should be free from interfering gases so as not to disrupt the determination of carbon and sulphur. The input filter for the oxygen contains sodium hydroxide (ascarite) and magnesium perchlorate to bind both CO_2 and water, thereby permitting a reliable determination of carbon and sulphur. For especially sensitive measurement tasks (e.g. determining 6 ppm carbon in steel), an external oxygen purification furnace can be purchased as an option; using a heated catalyser, this oxidises and removes the smallest traces of hydrocarbons so that a reliable determination is also possible in the lower ppm range.

Combustion:
The inductive furnace of the ELEMENTRAC CSi always requires a metallic (electrically conductive) component in the sample so that the energy in the furnace can be introduced to the sample. This task is assumed by the additives (tungsten, iron, copper). When the induction furnace is switched on, these additives are melted and are burned with the sample by the active oxygen flow.
The gaseous products SO2, CO2 are primarily created, together with very small quantities of CO and H2O. The SO2 originates from the combustion of the sulphur components in the sample, and the CO and CO2 are the combustion components of the carbon in the sample. H2O originates as moisture from the sample or from a very small quantity of hydrogen. The overall temperatures during combustion are over 2300 ° C. The high temperature comes firstly from the “melting capacity” of the furnace, and secondly from the reaction energy of the liquid metal with the oxygen carrier gas.

Filtering of the combustion gases:
In addition to the gaseous combustion products, dusts are also created that would interfere with the assessment. These are removed via a metal filter net. Similarly interfering gaseous H2O (water) is subsequently removed using a magnesium perchlorate filter.

Measurement of sulphur:
The purified SO2 gas is recorded in up to two independent infrared measuring cells (refer to the chapter on infrared measuring cells for the theory of infrared measuring cells. A longer measuring cell covers the sensitive measurement range (e.g. less than 0.1 % S), while the

other, shorter cell is able to measure the higher measurement range (e.g. 10 % S). The CO or CO2 contained in the carrier gas does not hinder this because the measuring cells selectively record only the sulphur connections.

Oxidation and removal of sulphur from the combustion gas:
In order to reliably record the carbon content of the sample, it is necessary to oxidise the traces of CO contained in the carrier gas to CO2, because only CO2 is measured in the ELTRA infrared measuring cells. This oxidation is guaranteed by a heated catalyser with platinum filling. In addition to the oxidation of CO to CO2, SO2 is also oxidised to SO3 and bound in the downstream cellulose filter.

Measurement of carbon:
As with the sulphur, the carbon as CO2 is recorded in up to two independent infrared measuring cells.

Presentation and calculation of the results in the software:
Throughout the analysis process, the ELEMENTS software collects data such as temperatures in the furnace and catalyser, as well as the “zero lines” of the individual detectors. If the SO2 and CO2 gases generated by the combustion then enter the infrared measuring cells, they change the zero lines which is shown as “peak” in the software (see the figure below). The area beneath the peak is then calculated and a measurement reading assigned to this area.

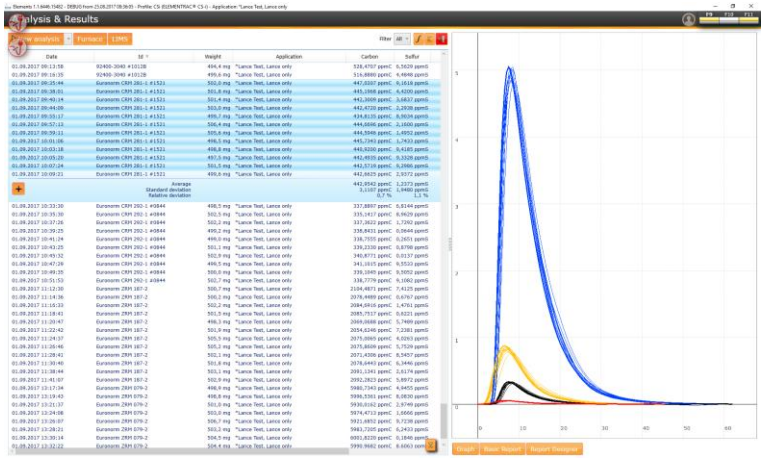


Fig. 27: Illustration of the peak

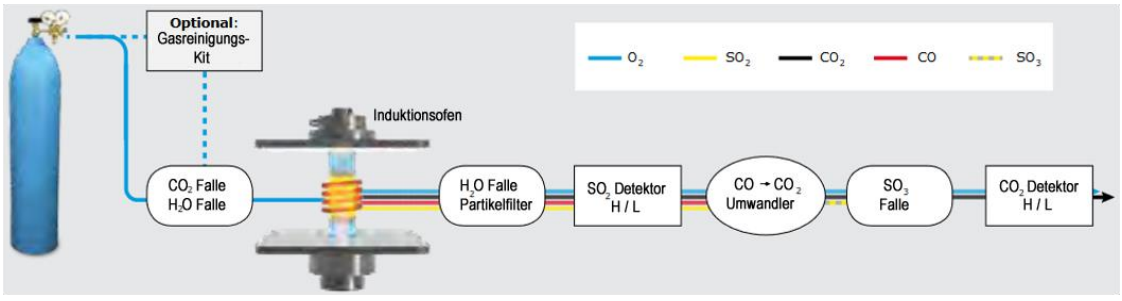


Fig. 28: Chemical reaction during the analysis

6.2 Gas flow diagrams

The CSi uses the following valves for control:

Valves	Description
CSV 1	Gas inlet valve
CSV 2	Lance valve
CSV 3	Flush valve
CSV 4	Detector flushing closing valve
CSV 5	Furnace exhaust closing valve
CSV 6	Induction furnace bypass valve
CSV 7	Valve switches between induction and resistance
CSV 8	Gas outlet valve
CSV 9	HTF, oxygen inlet valve (CSd)
CSV 10	Catalyst furnace bypass valve (CSd)
CSV 11	HTF pump valve (CSd)
CSV 12	Prop valve

	Description
R 101	Incoming oxygen purification
R 102	Moisture filter
R 103	Cellulose filter

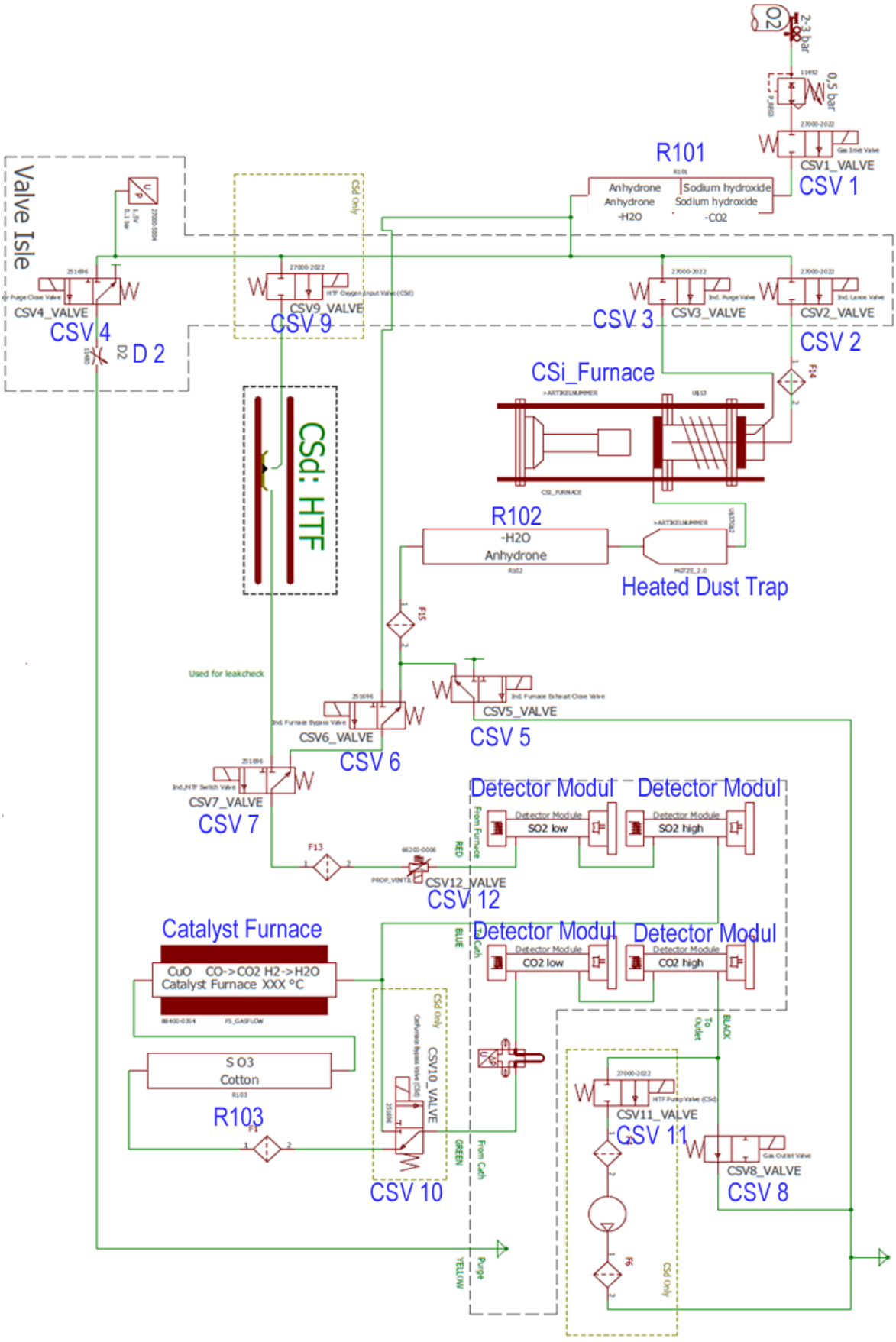


Fig. 29: Position of the valves

6.3 Chemicals

The following chemicals are used in the CSi:

Magnesium perchlorate (anhydrone)	As moisture absorbent
Sodium hydroxide (ascarite)	As CO2 absorbent
Platinised silica	As oxidising agent (CO→CO2)
Cellulose	For the absorption of SO3

The reagent tubes are replaced when they are saturated. Further information can be found in the Servicing chapter.
It is not possible to dry and reuse the magnesium perchlorate, because after reacting with the moisture, it has been chemically changed. The regeneration of sodium hydroxide (ascarite) and of the catalyser made of platinised silica is likewise not possible.
A saturation / consumption of the chemicals can be recognised according to the following criteria:

– Magnesium perchlorate / sodium hydroxide (ascarite)
  If the capacity of these chemicals has been reached, agglomeration (clumping) occurs on what previously were separate particles. If this phenomenon is observed, these chemicals must be replaced. This appearance of saturation strongly depends on the quality of the oxygen added and on the type of samples.
– Platinised silica
  As these chemicals are responsible for the oxidation of CO, there is a decreasing efficacy due to falling carbon readings. In this case the catalyser must be replaced.
– Cellulose
  This turns black over the course of the analyses. The higher the sulphur content of the sample, the faster the black colouring progresses. This chemical must be replaced at the latest when 50 % of the column has turned a dark colour.

NOTICE
Please comply with the safety data sheets and local regulations when handling the chemicals

NOTICE
Only use the chemicals sold by ELTRA. Other qualities may, despite the same brand name, lead to fluctuating measurement readings and damage to the analyzer.

6.4 Infrared cell

The measuring principle is based on the infrared radiation absorbing property of many gases. Each of these gases absorbs specific characteristic spectral wavelengths of infrared radiation. The absorption spectrum is determined by the number, configuration and type of the atoms in the gas molecules.

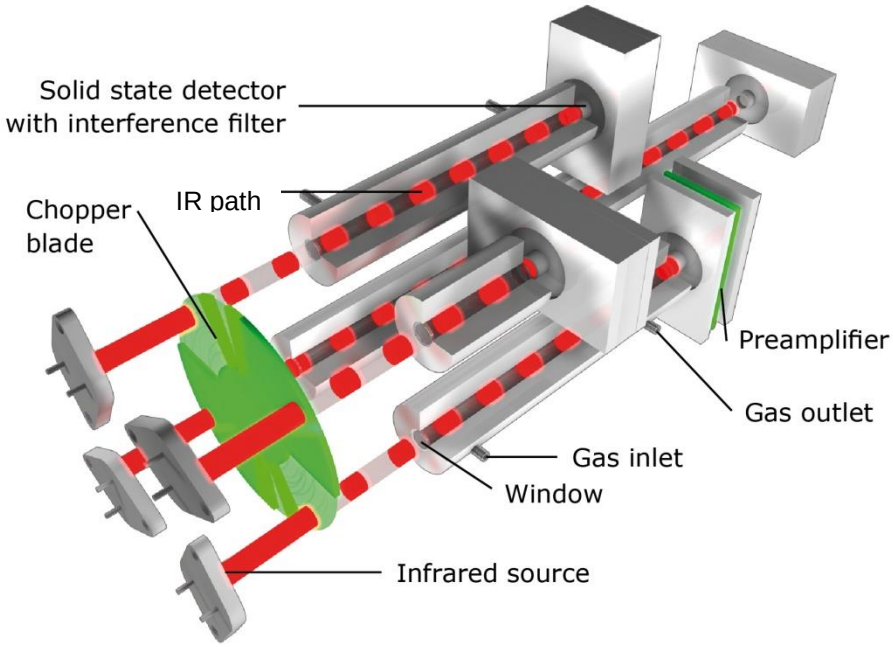


Fig. 2: Infrared cell

An infrared source is electrically heated emitting wide band infrared radiation. The radiation beam is interrupted by a rotating chopper blade, resulting in alternating light. The rotary speed of the chopper is designed to be very stable. The infrared radiation then passes through the measuring IR-paths, through which a mixture of combustion gases and carrier gas flows. Depending on the composition of the gas mixture, certain frequencies of the infrared spectrum are absorbed. The rate of absorption depends on the concentration of the gases.

As the infrared beam leaves the IR-path, it passes through an infrared filter, which allows only a certain narrow band of infrared radiation to pass. This narrow band must correspond to the IR wavelength for which the gas to be detected has its maximum absorption capability.

The intensity of the radiation after the filter thus corresponds to the concentration of a specific gas in the path. The beam is measured by a solid state infrared sensor, giving an electrical signal corresponding to the intensity of the beam.

As the beam is interrupted by the rotating chopper, the detector receives an alternating radiation creating an AC electrical signal. Temperature and aging influences of the detector, as well as noise are thereby strongly reduced.

The signal obtained is amplified, rectified and passed thru a low pass filter so that it leaves the infrared cell as a DC voltage.

The infrared cells utilize solid state sensors combined with infrared filters. The infrared cell module can be equipped with up to four independent infrared sensor banks.

The lengths of all four cells can be individually optimized to obtain maximum precision for the target analysis levels of each customer. Each of the cells can be installed with infrared absorption lengths ranging from 1 mm to 320 mm. The infrared cell rack is temperature controlled so that the sample gas flowing through it is kept at a constant temperature.

The infrared cell rack is temperature controlled, so that the sample gas which flows through it, is kept at a constant temperature.

6.5 Furnace

The combustion of the sample on the ELEMENTRAC CSi occurs in a high frequency induction furnace. The crucible with sample and additive is put into the induction coil of the oscillating circuit of the sample stand, then heated by a high frequency induction and burned by the addition of oxygen. On starting the analysis, the high voltage supply of the high frequency

generator is switched on. Inside the coil is a quartz tube that is attached to an upper and lower support. The gas flows downwards. The furnace entrance runs through a lance which blows the oxygen for combustion directly into the crucible and onto the burning sample. When the sample is taken from the sample stand and into the furnace, the lower opening of the quartz tube is sealed with the cone plug.

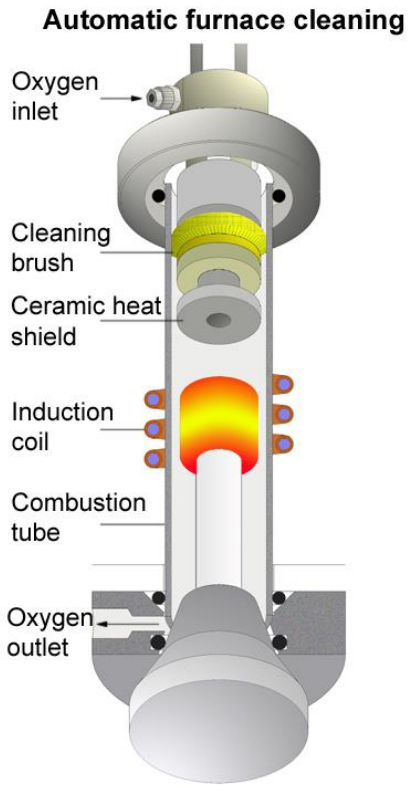


Fig. 30: Automatic cleaning of the induction furnace

Depending on the application, different quantities of dust arise during combustion, which collects in the combustion tube or the metal filter. This concerns oxides of the additive (usually tungsten or iron oxides), as well as oxide residues from the sample. The furnace of the ELEMENTRAC CSI is automatically cleaned using the integrated brush after every analysis to obtain reproducible analysis results. The standard cleaning apparatus is mechanically located on the opening/closing system of the furnace to ensure that the cleaning brush does not collide with the hot sample crucible. The cleaning brush is also protected by a ceramic heat shield.

6.6 Leak checking

⚠ CAUTION C19.0091

Chemicals / sample material spurting out

Excess pressure in the system

- **No change of reagents may take place during the leak test or analysis.**

To guarantee a reliable and complete analysis of carbon and sulphur, when checking the analyzer it makes sense to occasionally conduct a leak test to ensure that no analysis gas (CO2 or SO2) is escaping from the system, thereby causing results that are too low during the carbon/sulphur analysis

During the leak test, excess oxygen pressure is fed into the lines, furnace and measuring cells

of the analyzer, and the pressure drop measured over a defined period. If this pressure drop is below a set value (refer also to the window settings in the software manual, the leak test is marked as having been passed by adding a green tick in the text field. If the pressure drop is above this level, the pressure drop is marked as having failed the test.

NOTICE

Analyses can still be conducted in the case of a failed leak test. If the pressure loss identified is negligible and control standards within the specification can be measured, the analysis of unknown samples is also possible.

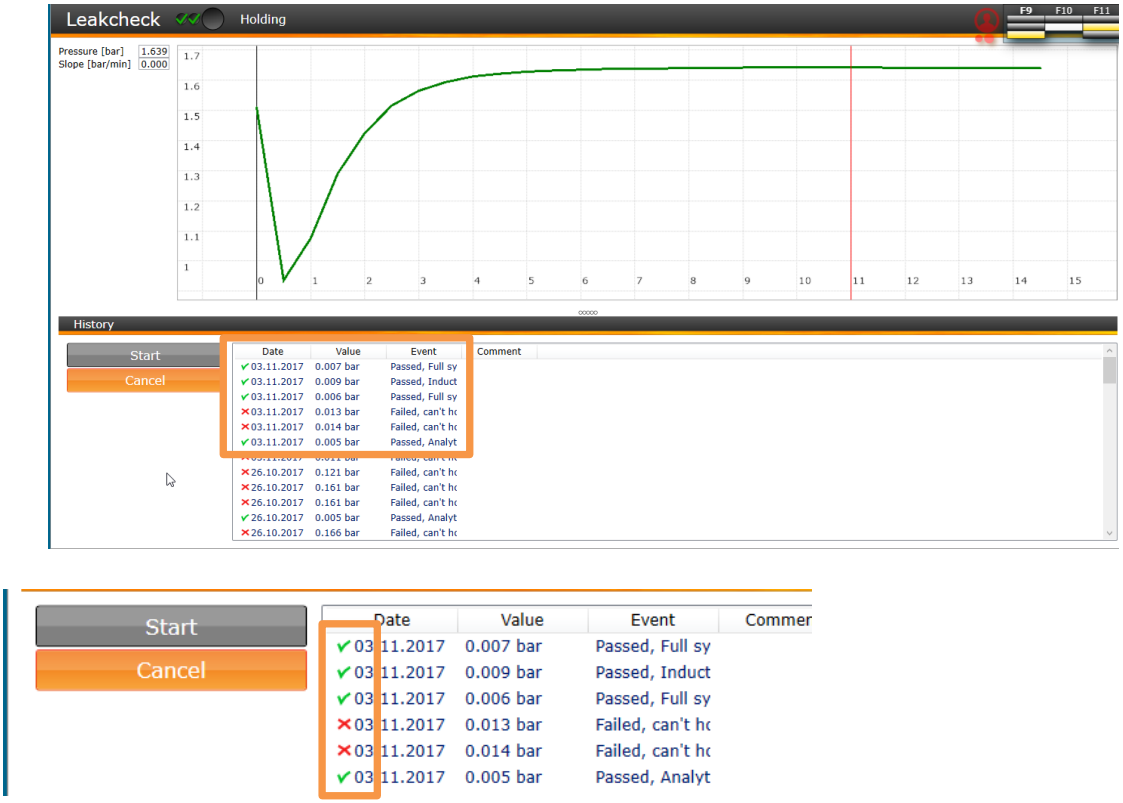


Fig. 31: Leak test passed / failed

The “Leak test” window is opened by repeatedly pressing the F 10 button.
Typical sources of leaks are primarily found in the furnace segment. These include the following:

– Defective combustion tube;
– Worn O-rings on the combustion tube;
– Leak in combustion hose from the combustion tube to the metal filter.

NOTICE

For further information on the subject of the “leak test”, please refer to the software manual.

7 Components of the analyzer

7.1 Front panel illustration

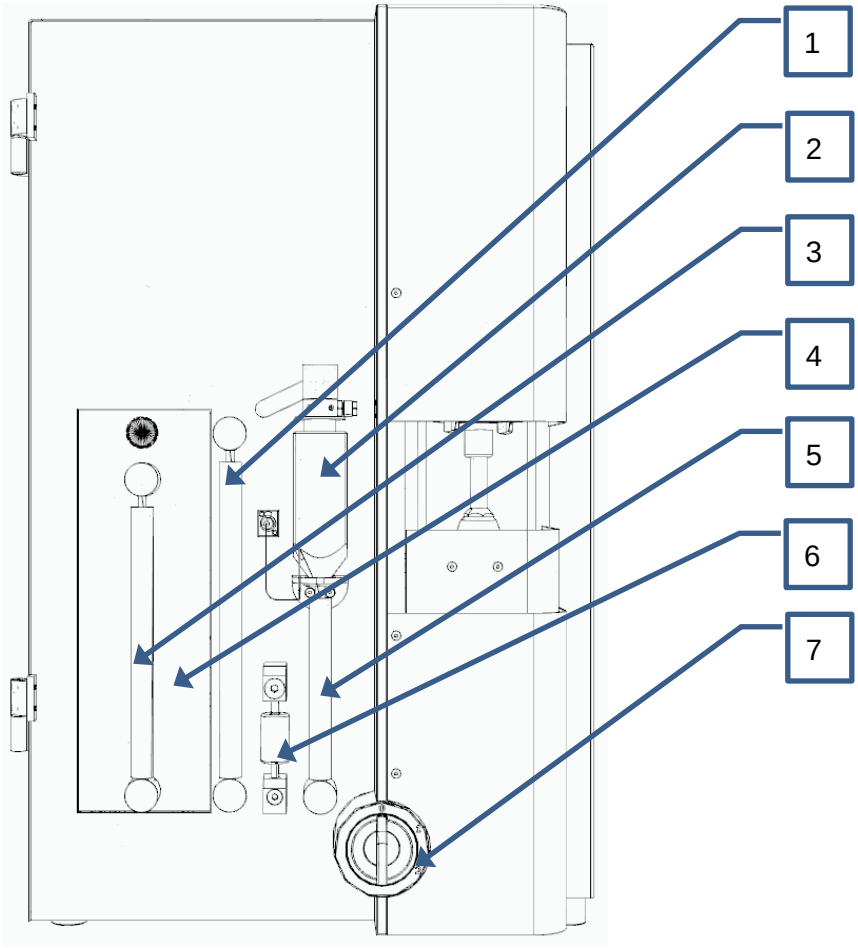


Fig. 32: View of the device from the front

No.	Description
1	CO2/H2O trap
2	Heated dust filter
3	SO3 trap
4	Catalyst furnace
5	H2O trap
6	Dust filter cartridge
7	Mains switch

7.2 Left side illustration

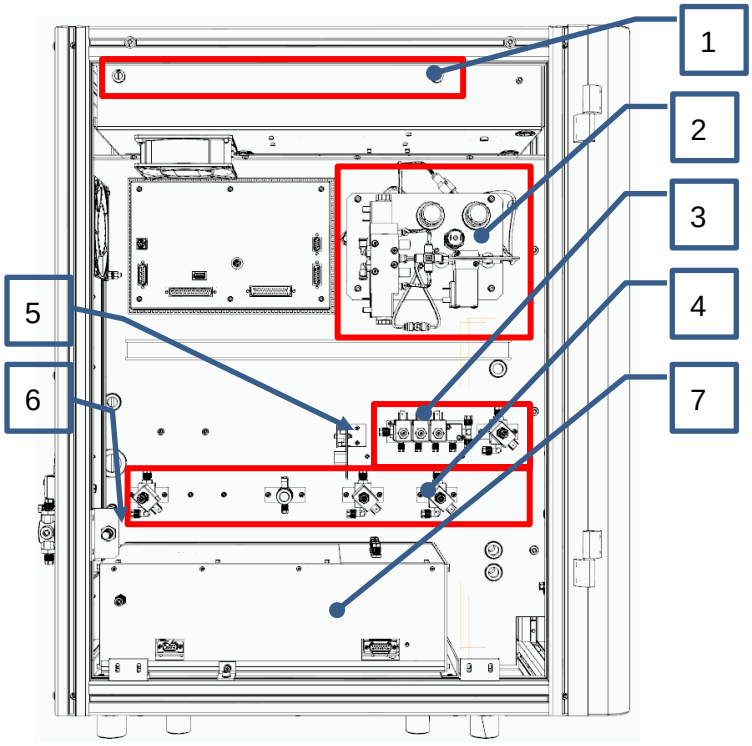


Fig. 33: View of the device from the left

No.	Description
1	Safety fuses
2	Control of compressed air supply
3	Valve terminal: CSV2, CSV3, CSV4 and CSV5
4	Valve terminal: CSV6, CSV7, CSV8 and CSV12
5	Pressure sensor circuit board
6	Throttle valve D2
7	IR cell

7.2.1 Angled view from the left

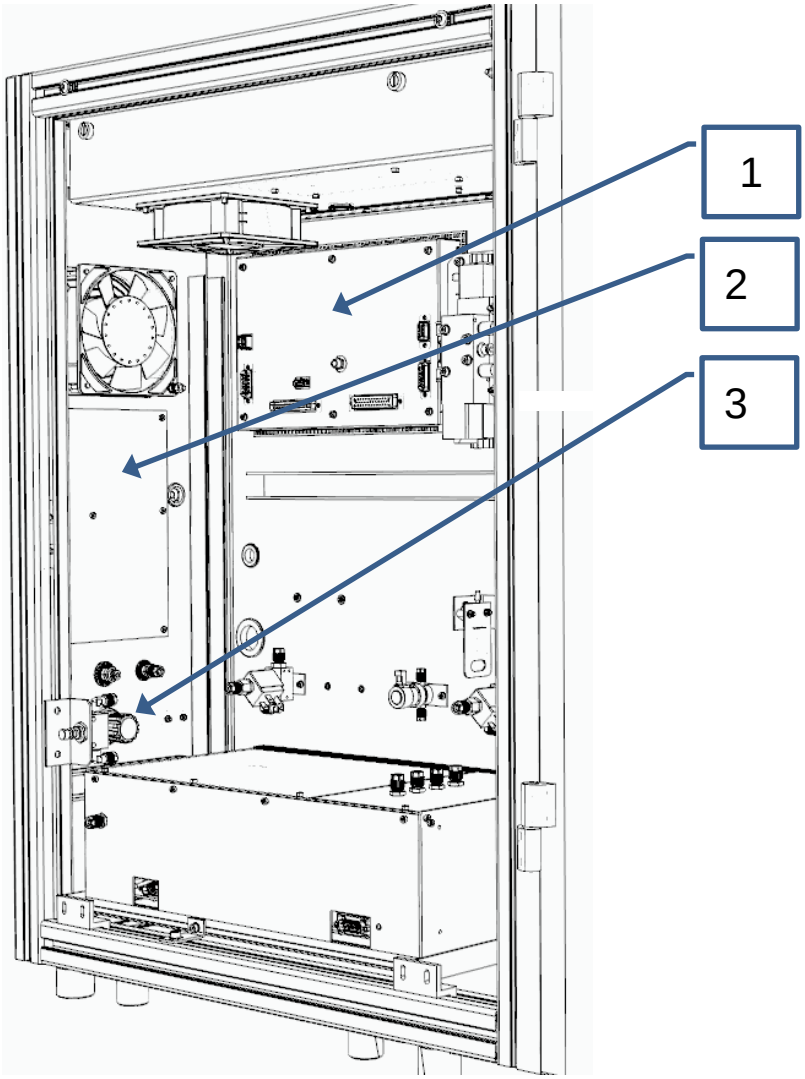


Fig. 34: Angled view from the left

No.	Description
1	Connection plate UNI_2
2	DevGate circuit board
3	Input pressure regulator

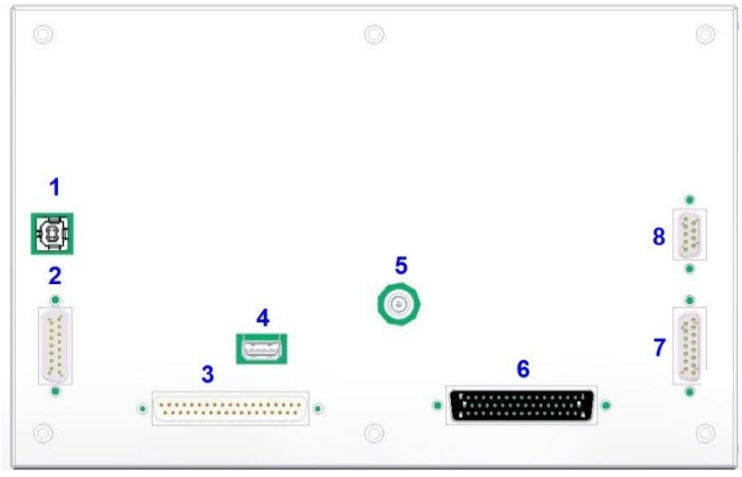


Fig. 35: Connection plate UNI_2

No.	Description
1	USB connection for analyzer to PC
2	Not assigned POWER / TEMP control
3	Analogue I/O signals
4	Not assigned PUMPcontrol
5	Power supply (Percy)
6	Digital I/O signals
7	Loader
8	Recording of the furnace temperature and switching of the LED module

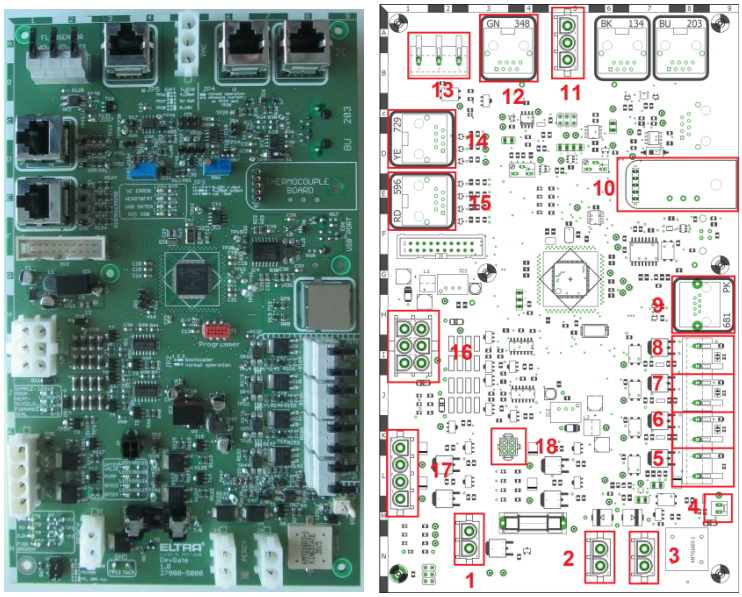


Fig. 36: Front of the DevGate

No.	Name	Description
1	J1	Input power supply
2	J3	NN
3	J2	Output power supply Uniboard
4	X9	Prop valve connector
5	X11	Safety circuit output
6	X14	Safety circuit 3 input, safety switch on the generator metal sheet
7	X13	Safety circuit 2 input, cylinder position at top
8	X12	Safety circuit 1 input, pneumatic pressure switch
9	X6	NN
10	SV1	Thermoelement board connection
11	J5	PAC module connection
12	X8	Gas flow sensor connection
13	X10	Monitoring fan
14	X7	KFPC board connection

15	X15	NN
16	J4	NN
17	J6	Fan speed connection
18	J7	Fan connection

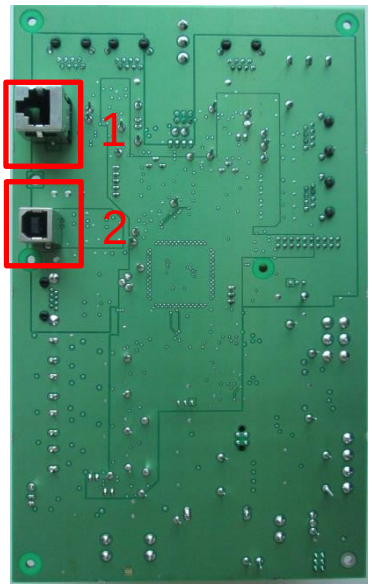


Fig. 37: Back of the DevGate

No.	Description
1	Extension connection
2	USB connection to PC

The computer is already supplied with an installed operating system and software to control the analyzer. The interface of the balance is programmed according to the configuration required for transmitting the weight data to the PC.

NOTICE

Information to operate the analyzer via the PC can be found in the software instructions.

7.3 Right side illustration

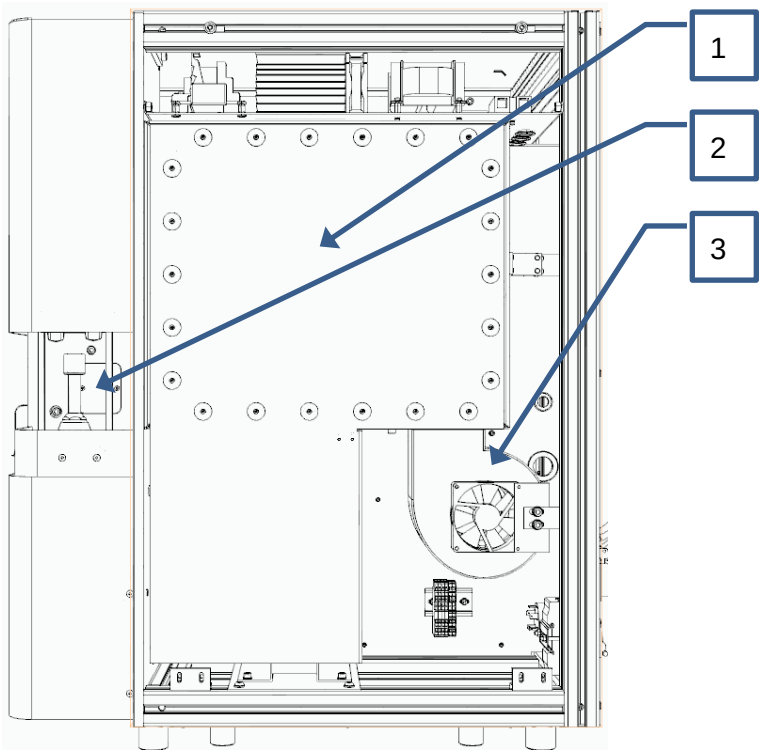


Fig. 38: View of the device from the right

No.	Description
1	Oscillator cover
2	Furnace light cover
3	Fan

7.4 Back side illustration

⚠ CAUTION C20.0119

The sockets on the back of the CSi are not permanently supplied with electricity.
There is a risk of damage to connected devices.
Source of the danger.

- When switching off (switch position 0), all connected devices are no longer supplied with electricity. The hazard potential here must be individually assessed.
- A socket has been specially designed for the vacuum cleaner and is only switched at times. Connected devices are always only supplied with electricity for a short time.
- Overall the permissible electricity is limited. If consumers are connected whose power consumption is too high (e.g. furnaces), there is a risk of overloading the electricity supply.

- **Never connect the PC controlling the CSi to these sockets.**
- **Only connect accessories recommended by ELTRA.**
- **Consult their safety officer**.

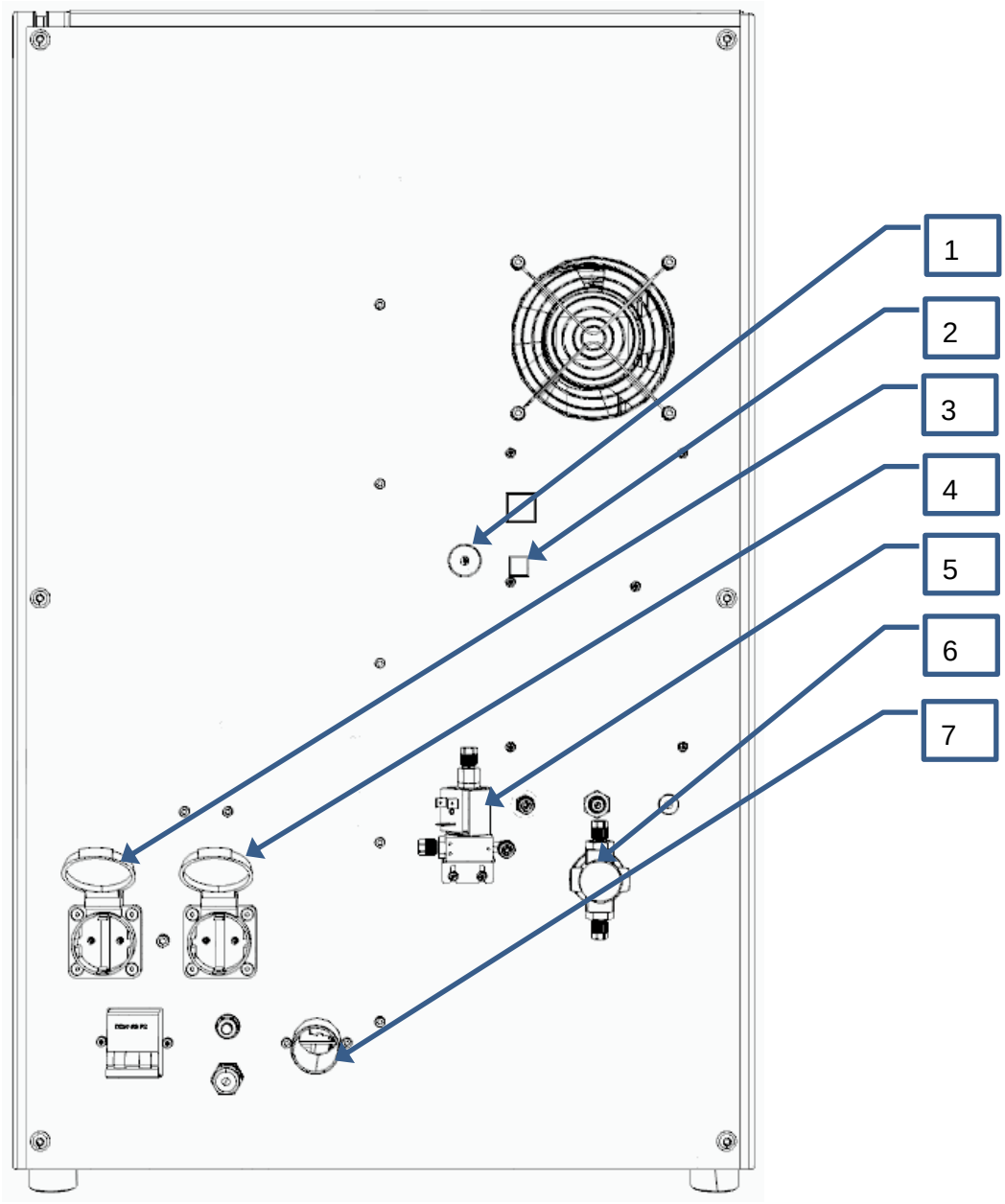


Fig. 39: View of the back ,

No.	Description
1	PC-UNI
2	PC-DevGate, electronic controller
3	Socket
4	Socket, ONLY FOR VACUUM CLEANER!
5	Oxygen valve, CSV 1
6	Oxygen input
7	Vacuum cleaner input

7.5 View from above

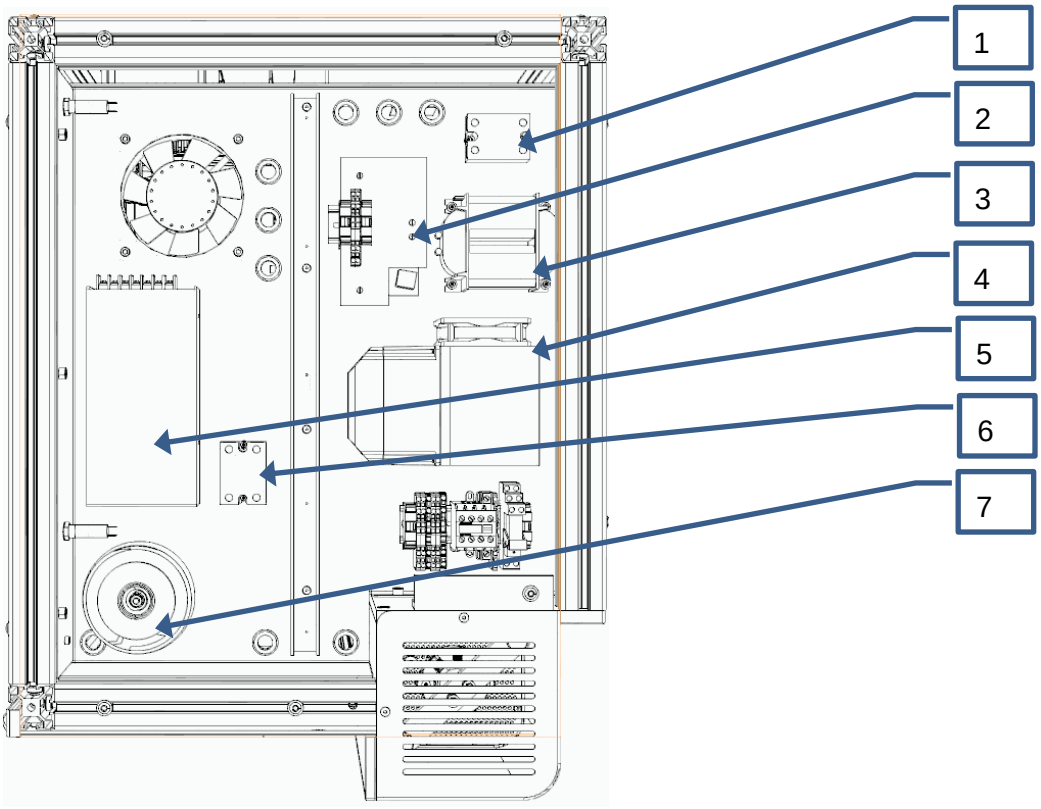


Fig. 40: Plan view,

No.	Description
1	40A semi-conductor relay
2	PCB board
3	Transformer
4	Maxthermo power controller
5	Power supply unit
6	40A semi-conductor relay
7	Toroidal transformer catalyst furnace

8 Maintenance

⚠ CAUTION

C21.0074

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- C**heck the furnace temperature in the software.**
- **For maintenance the furnace temperature has to be less than 40°C.**

8.1 General information

The following service instructions refer to common steel analysis with 10-30 samples per day and 99.5 % pure oxygen. Depending on the application, the service cycle must be intensified to maintain the precision of analysis results. The following table contains both the number of possible analyses and a time specification. Servicing must be conducted when one of the two criteria has been met:

Component to be serviced	Analysis service interval	Time service interval	Supplementary service instructions	See chapter
Dust filter with metal filter	100	Daily	Empty dust and brush clean	8.4
Magnesium perchlorate behind metal filter	100	Monthly	Replace when clumping is visible	8.3.6
Metal filter thorough	500	Monthly	Replace when rust is visible	8.4.2
Connection combustion tubes – metal filter	5000	Monthly	Clean or replace where necessary	8.7
Combustion tube	1000	Monthly	Check, clean and replace where necessary	8.5.2
Brush heat shield clean	100	Monthly	The heat shield requires cleaning depending on the sample; replace where necessary	8.5.1
Input gas purifier	1000	Every 3 months	Replace earlier if clumping is visible	8.3.3
Furnace cleaning brush	2000	Every 3 months		8.5.1
Cellulose	2000	Every 3 months	Replace when 50 % of the filter	8.3.4

			is black	
Dust filter cartridge (Balston filter)	500	Twice a year	Replace when dark colouring can be seen	8.3.5
Catalyser	20000	Once a year		8.3.2
O rings Combustion range Catalyser Metal filter	35000	Once a year	Annual servicing recommended	8.6 9

8.2 Reagent tubes – removing and installing

⚠ CAUTION

C22.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

⚠ CAUTION

C23.0095

Injuries in the form of cuts and other personal injuries
Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged glasware and glass splitters.
- **Replace damaged glassware / reagent tubes**
- **Do not touch glass splitters with your hands.**

⚠ CAUTION

C24.0081

Danger of bursting

– Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.
- **Before installing the new reagent tubes, check if they are damaged.**
- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**

⚠ CAUTION

C25.0090

Risk of injury to eyes
Chemicals

– When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

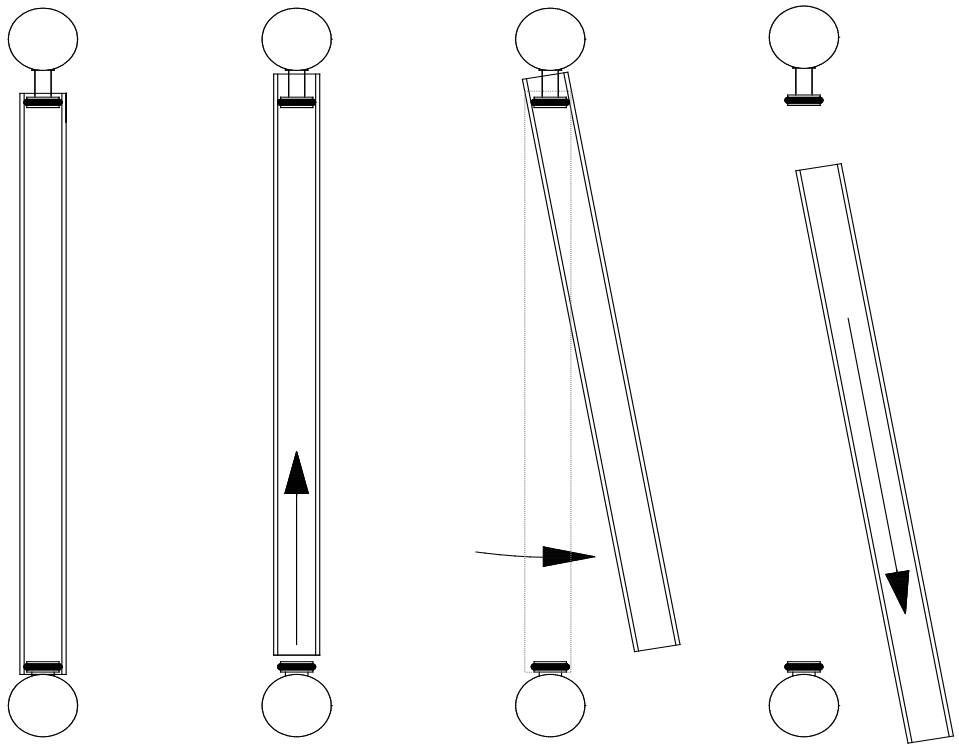


Fig. **41:** Installing and removing reagent tubes

NOTICE

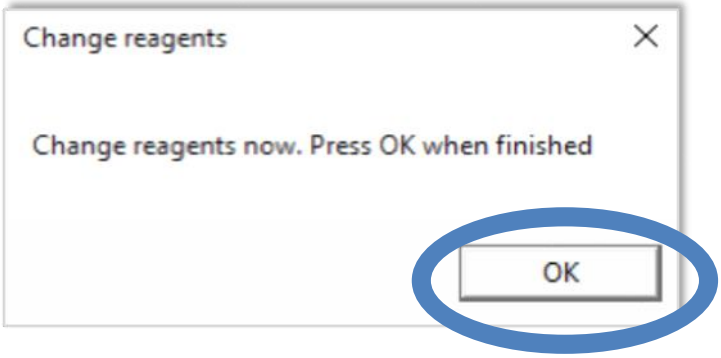
The reagent tubes must not be replaced during operation because the system is under pressure! If you only want to remove the dust traps, e.g. for cleaning the furnace, this is also possible without releasing the pressure!

- Set the analyzer to Position 1.
- Relieve the pressure from the system by clicking on the reagent change button in the software. This is found in the “Analyzer status” window in the software.
- Slide the reagent tubes up slightly, pivot them to the side and then remove them diagonally downwards.
- Clean the connections and grease the O-rings.

NOTICE

Before attaching the reagent tubes again, the O-rings and the inner ends of the tubes are lubricated lightly with high vacuum silicone grease (Item No. 92610).

- Empty the reagent tubes.
- Fill the reagent tubes again (see the following chapter) and install the components again in reverse order.
- Confirm the “Change reagents” message to return the analyzer to normal mode – see the figure below.



8.3 Reagent tubes filling

8.3.1 Chemicals

⚠ CAUTION C26.0091

Chemicals / sample material spurting out
Excess pressure in the system

- **No change of reagents may take place during the leak test or analysis.**

⚠ CAUTION C27.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

⚠ CAUTION C28.0090

Risk of injury to eyes
Chemicals

- When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

⚠ WARNING W11.0017

Danger of toxication and personal injuries

- Some chemicals may cause a fatal toxication or dangerous skin corrosion.
- **Refer to the material safety data sheet of the used substances.**
- **Never eat or drink close to the chemical substances.**

⚠ WARNING W12.0022

Burning of the skin, eyes and respiratory system.
Corrosive substances:

- Corrosive substances can cause burning of the skin, eyes and respiratory system.
- **Refer to the material safety data sheet for the substance being used.**
- **Always wear suitable clothing, including protective gloves and eye protection.**

See chapter 6.3 on Chemicals for general information about chemicals.

8.3.2 Catalyst furnace, fill PT / Si

CAUTION

C29.0094

Scalding/burns

Hot furnace / hot combustion pipe / hot analyzer parts

– The furnace temperature can get up to 800°C during operation
Only change the copper oxide after allowing sufficient cooling time.

• **Wear heat-resistant protective gloves.**

- Switch to a catalyst furnace cooling application (set point = 0°C).
- Open the doors.
- Open the catalyst furnace doors (reduces the cooling time).
- Wait until the catalyst furnace has reached room temperature.
- Release the lock of the catalyst furnace by turning to the left – see the figure below.

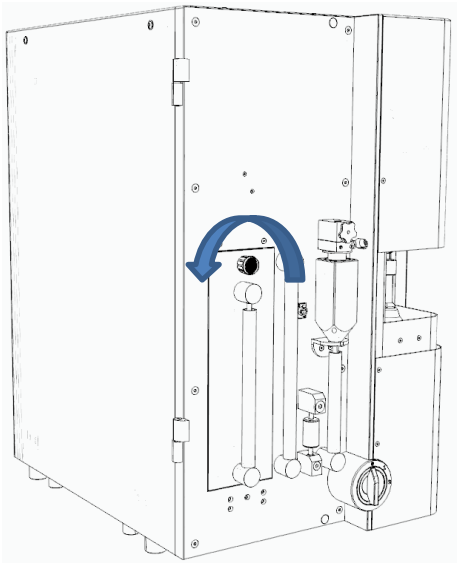


Fig. 42: Catalyst furnace lock

– The catalyst furnace unit tilts forwards slightly.

Fig. 43: Tilted catalyst furnace

- Using pliers, release the clamp holding the hose on the quartz tube, and slide it over the tip of the quartz tube as shown in the illustrations below.

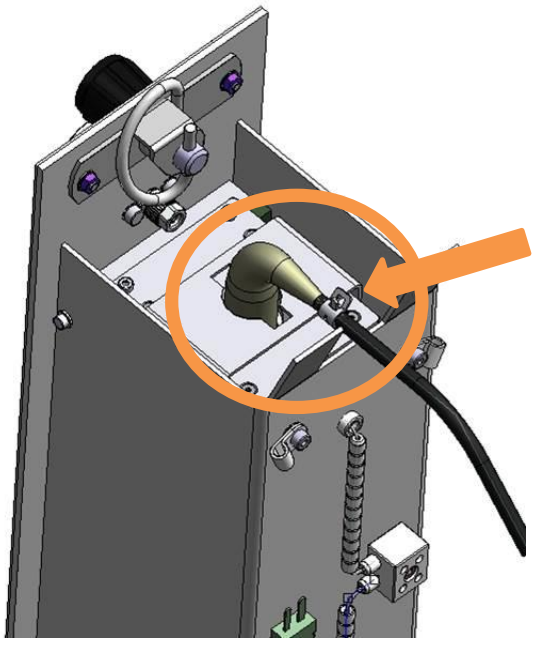


Fig. 44: Hose clamp

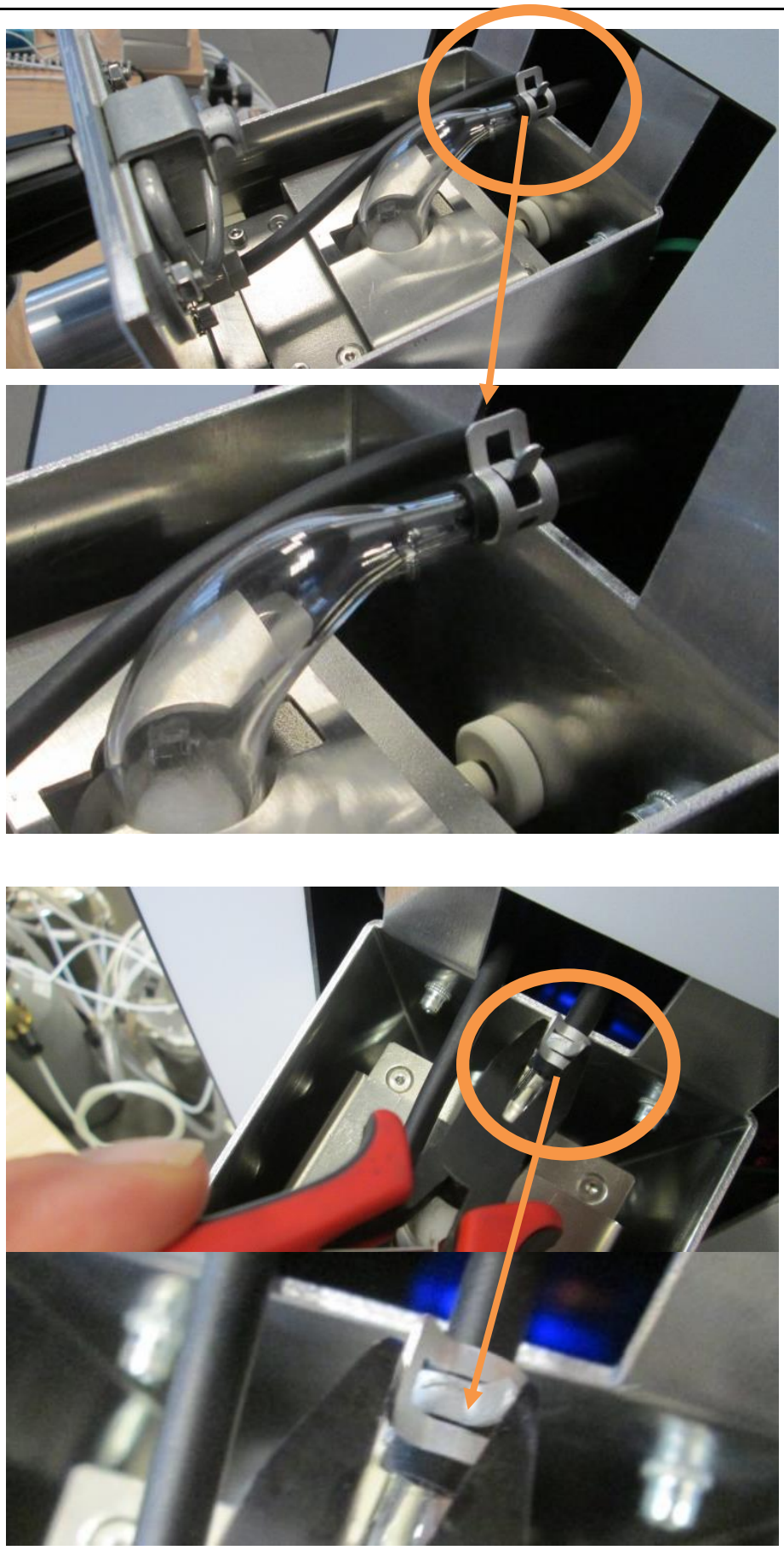


Fig. 45: Releasing the clamp on the quartz tube of the catalyst furnace

Fig. 46: Removing the clamp on the quartz tube of the catalyst furnace

- Carefully slide the hose from the quartz tube and remove the clamp. Place this on the device.
- Then turn the quartz tube 90° to the right.

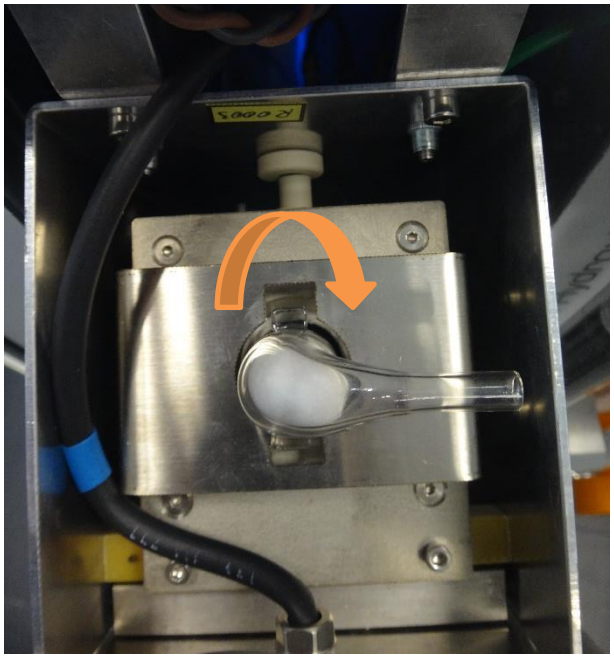


Fig. 47: Rotated quartz tube

– The tube has two nibs as guide. The tube can only be pulled out when these nibs sit correctly in the guide.

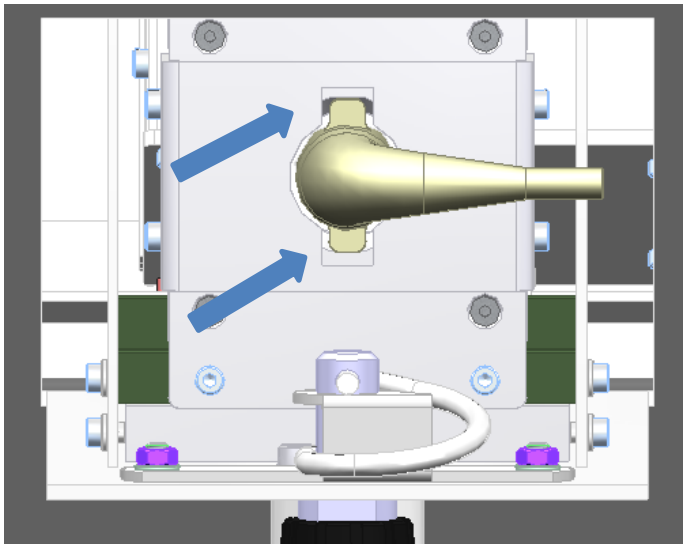


Fig. 48: Quartz tube guide

- Release the quartz tube from its support by gently wiggling the tube. Then pull the tube upwards slightly.

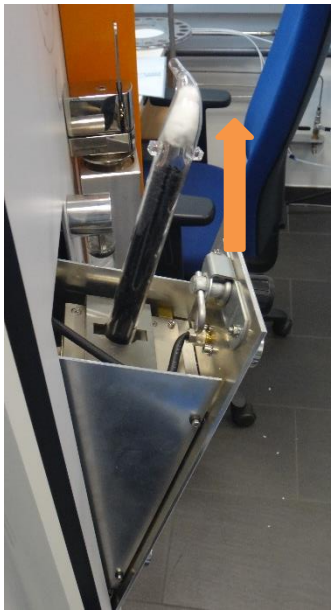


Fig. 49: Removing the quartz tube

- Pull the quartz tube right out of the catalyst furnace and fill it as follows.

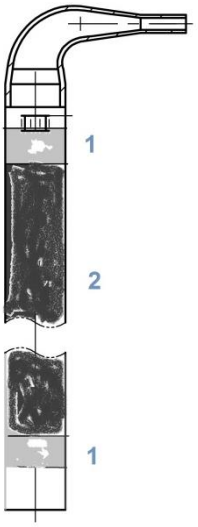


Fig. 50: Catalyst furnace, reagent tube

1	Quartz wool	90330
2	Platinum/silicon catalyser	88400-0535

- Assemble everything in reverse order.

NOTICE

Take care to pull the clamp over the hose before assembly.
The hose must be pushed at least 5 mm over the tip of the glass tube

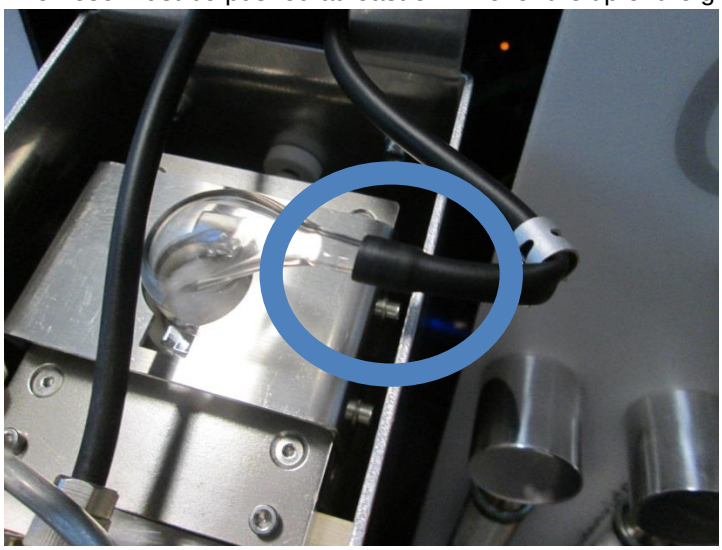


Fig. 51: Sliding the hose onto the quartz tube

8.3.3 Incoming oxygen purification

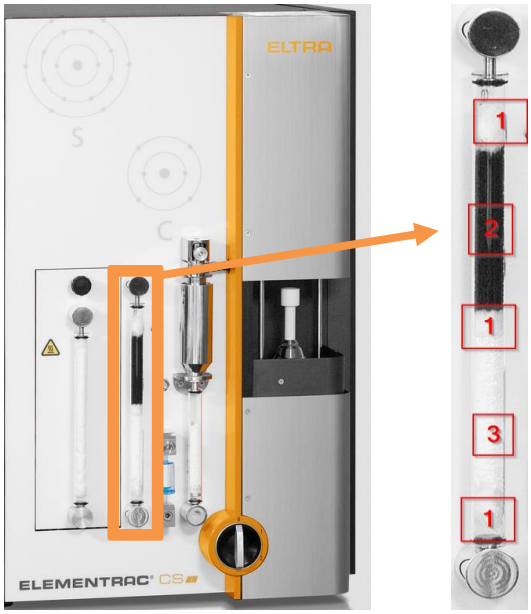


Fig. 52: Incoming oxygen purification

- Remove the incoming oxygen purifier as described in Chapter 8.2. and fill the column with the following chemicals as shown in the figure:

1	Glass wool	90331
2	Sodium hydroxide (ascarite)	90210
3	Magnesium perchlorate	90200

– The glass wool should be filled to a height of 0.5 to 1 cm. Too little glass wool results in the chemicals seeping through, while if the glass wool filling is too high, this leads to poor gas flow.

8.3.4 Cellulose filter

Fig. 53: Cellulose filter

- Remove the incoming oxygen purifier as described in Chapter 8.2. and fill the column with the following chemicals as illustrated:

1	Cellulose	90341

8.3.5 Changing the dust filter cartridge (Balston filter)

The dust filter cartridge filters the smallest dust particles from the combustion gases. Its saturation depends on the sample material and its combustion properties. The filter material in a new cartridge is white. Replace the dust filter cartridge when the filter material is discoloured, or after 500 analyses at the latest.

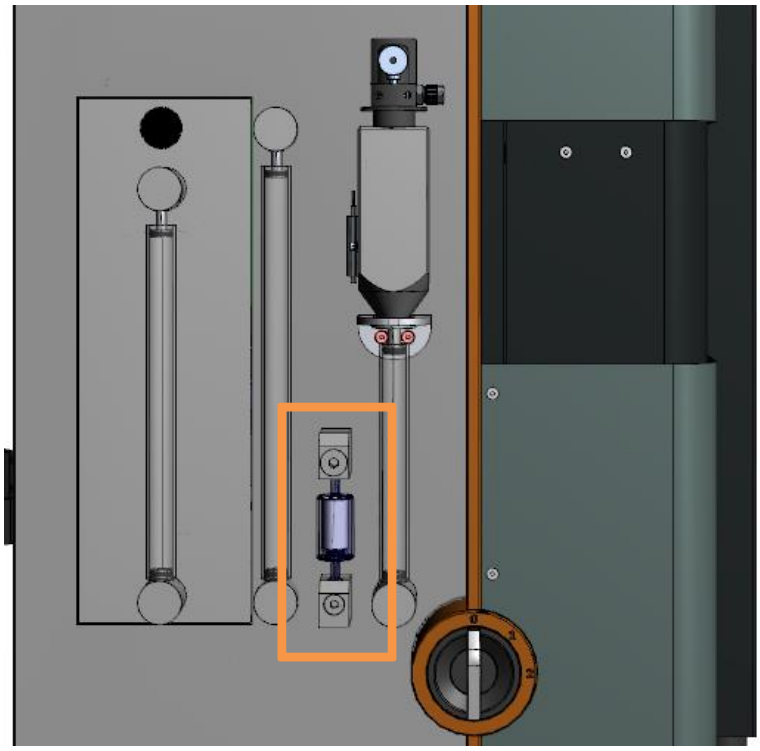


Fig. 54: Position of the dust filter cartridge

1. Lift the dust filter cartridge (**1**).
2. Pivot the bottom end forwards and pull the cartridge downwards to remove it.
3. Install a new cartridge by proceeding in reverse order.

NOTICE

Please note that the diameter of the cartridge is smaller at the top than at the bottom.

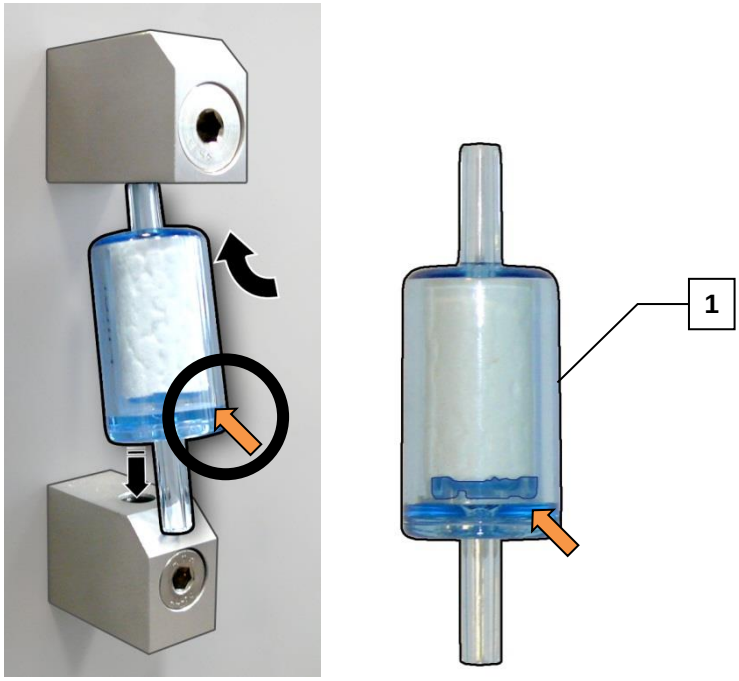


Fig. 55: Inserting the dust filter cartridge

8.3.6 Replacement of the moisture trap and the paper filter

Fig. 56: Moisture trap replacement

Remove the moisture trap as described in chapter 8.2. and remove the paper filter holder with paper filter (2) as described below. Make sure to place the magnesium perchlorate filling (1) in a collecting vessel. If this filling is very clumped by the absorption of moisture, remove the clumped reagent with a suitable device (eg spatula). After applying a new paper filter (see figure below), add new magnesium perchlorate (1) until the column is 75-90% full. Do not apply glass or quartz wool to magnesium perchlorate. This could absorb moist sulfur dioxide and thus falsify the measurement results.

For this maintenance you need the following spare parts / chemicals / tools:

Paper filter (10 pieces)	11185
Magnesium perchlorate (anhydrone)	90200
Possibly. Replacement paper filter holder	11120
Optionally replace O ring on paper filter holder	70230
Threaded rod for removing the paper filter holder	88400-0332

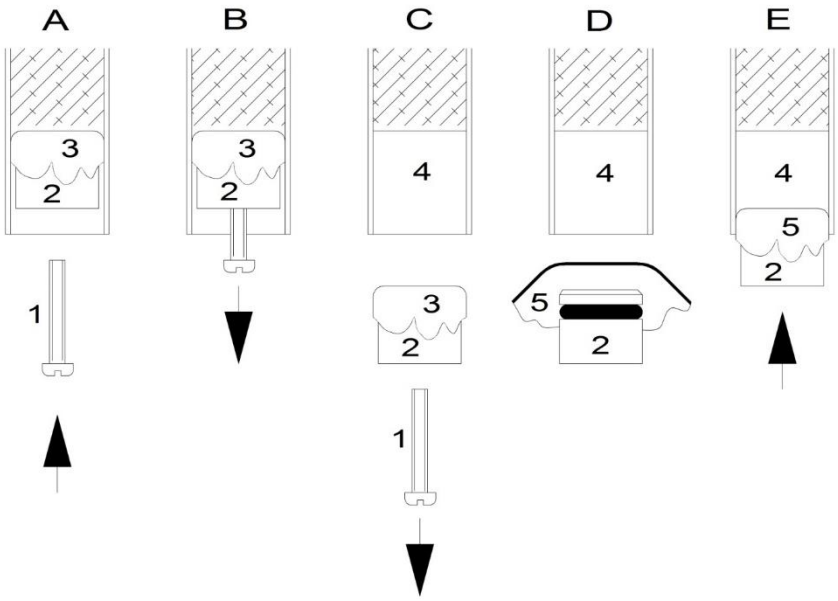


Fig. 57: Paper filter changing

A. Screw an M4 screw (1) into the paper filter holder (2).

B. With this screw, pull the filter holder (2) and the filter (3) out of the reagent tube (4).

C. Remove the screw (1) from the filter holder (2). Remove the old filter (3).

D. A new filter (5) is placed on the filter holder (2) and folded over.

E. The filter holder (2), with the new filter (5) is pushed carefully, back into the reagent tube (4).

8.3.7 Oxygen purification furnace quartz tube filling (optional)

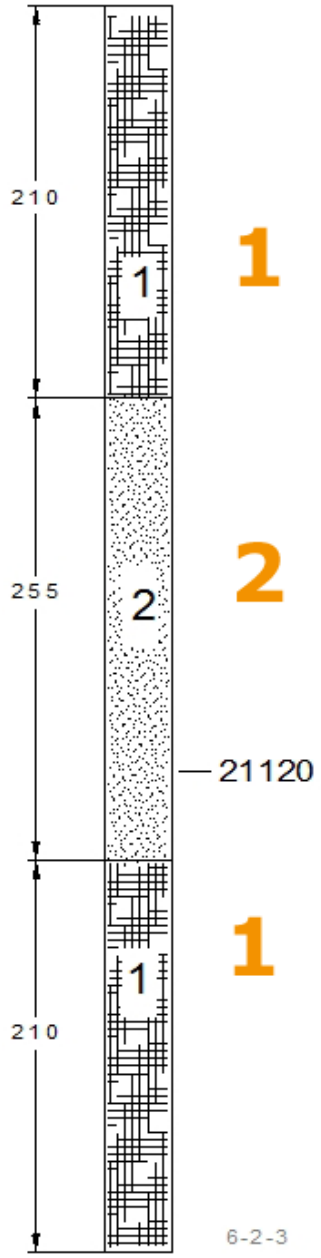


Fig. 58: Glass tube in the oxygen purification furnace

Keep to a tolerance of around ± 20 % of the fill level in the drawing.

No.	Material	Order number
	Glass tube for oxygen purification furnace	21120
1	Quartz wool	90330
2	Filling for gas purification furnace	88400-0122

8.4 Dust trap cleaning

⚠ CAUTION

C30.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

The dust trap prevents fine dust penetrating the infrared measuring cells of the analyzer, which can cause damage in the long term. They must be cleaned to prevent an absorption of the reaction gases and associated results that then are too low. For both methods the metal filter holder must first be removed.

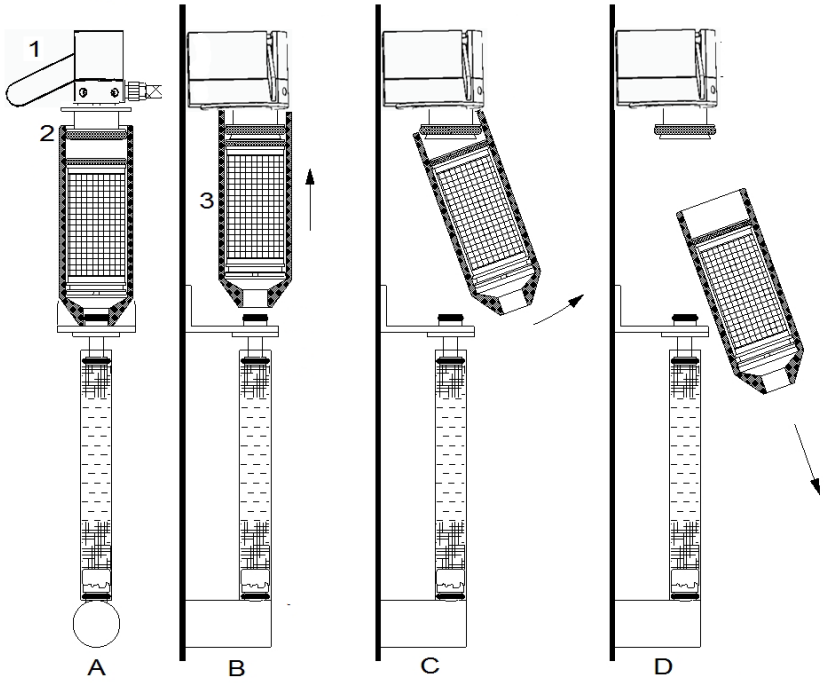


Fig. 59: Removing the dust trap

A	Release the coupling on the metal filter heating. The lock (1) is twisted 90° to the left to release the O-ring (2)
B	The dust trap (3) is lifted as high as possible.
C	It is then pivoted to the side and
D	angled downwards to remove it

Clean the dust trap (3) in accordance with Chapter 8.4.1. or 8.4.2. and install the parts again in reverse order after cleaning.

8.4.1 Fast cleaning of dust trap

This must be carried out at the latest after every 100 analyses or daily:

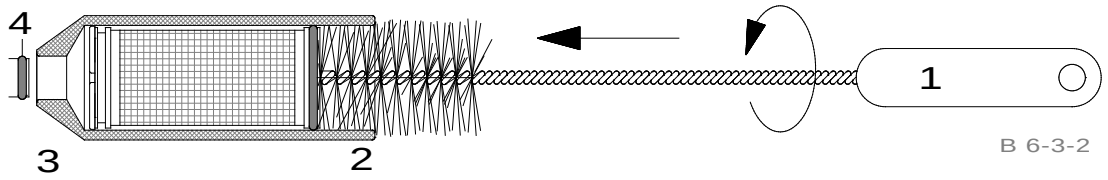


Fig. 60: Fast cleaning of the dust trap

- Using the brush supplied (1), transfer the dust **from the metal filter to a suitable waste container**.
- Only rotate the brush in one direction
- Clean the top end of the filter housing (2)

NOTICE

Only the bottom end of the filter housing **(3)** and the bottom O-ring **(4)** are greased. The top end of the filter housing **(2)** and the O-ring on the top seal mechanism should be clean and remain completely **free from grease**.

8.4.2 Thorough cleaning of dust trap

This must be carried out after every 500 analyses or monthly.

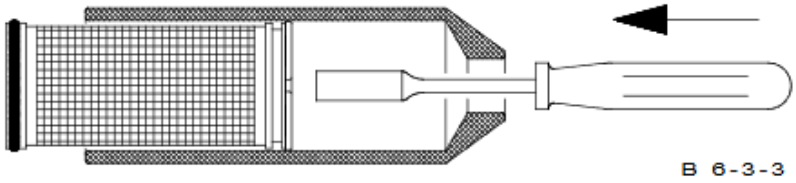


Fig. 61: Dismantling the dust trap

- Remove the metal filter from the filter housing.
- Carry out preliminary cleaning using the brush.
- Clean the metal filter in the ultrasound cleaning bath (71007).
- Dry the O-ring and grease it where necessary for installation.
- Clean the top end of the filter housing (2) to remove grease.

NOTICE

The O-rings must be correctly installed when reinserting the filter in the filter housing. The gas flow will otherwise be completely blocked.
External O-ring at the top, inner O-ring at the bottom
Ensure that only a completely dry metal filter is reinserted.

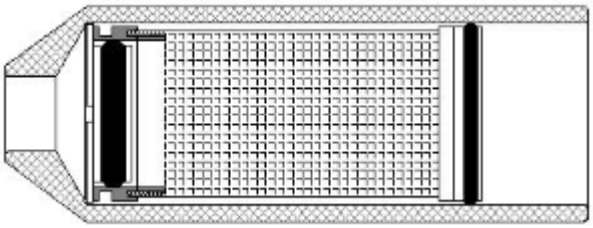


Fig. 62: Assembled metal filter

8.5 Servicing in the furnace area

DANGER

D2.0005

Mortal danger from electric shock
Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

CAUTION

C31.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

8.5.1 Replacing the furnace cleaning brush and heat shield

The furnace is equipped with an automatic cleaning system (brush) and heat shield.

- Unscrew the 3 Allen screws on the top furnace lining and put these to one side.

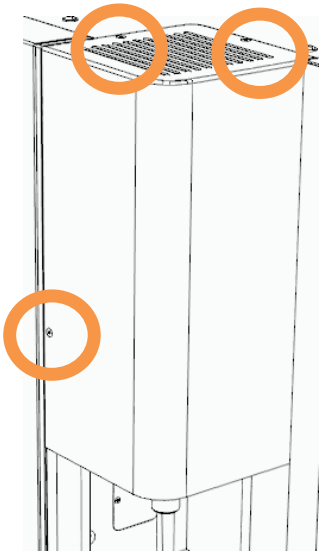


Fig. 63: Removing the top furnace lining

- Open the furnace.
- Set the device to Position 0 and pull the main plug out.

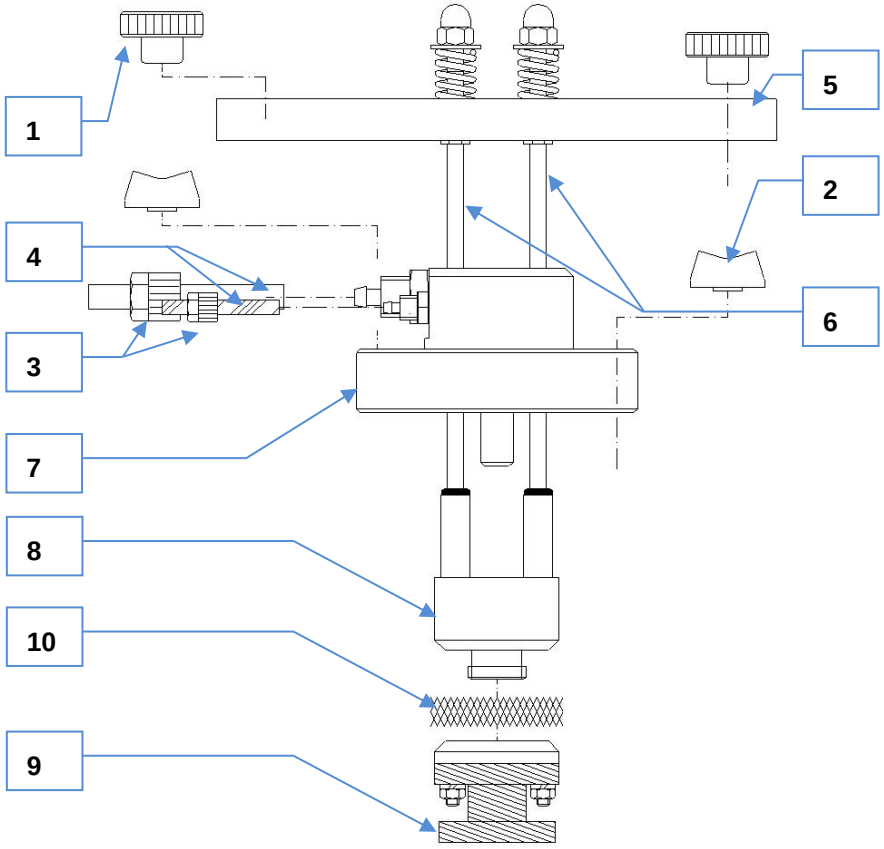


Fig. 64: Replacing the furnace cleaning brush

- Remove the knurled nuts (1).
- Unscrew the wing nuts (2).
- Unscrew the nuts (3) and remove the gas hoses (4).
- Remove the cleaning system of the furnace by lifting the support (5).

Fig. 65: Furnace cleaning system

- Hold the brush holder (8) tight and detach the heat protection (9) together with its brass ring.

NOTICE

When detaching the heat protection (9, it is very important) that you hold onto the brush holder (8) and not the support (5); if you do not, the rods will be bent (6).

- Remove and replace the brush (10) and the heat protection where applicable.

- Install the parts again by proceeding in reverse order.

NOTICE

During assembly, take care to tighten the wing nuts in the top end of the furnace evenly and securely.
Check whether the top end of the furnace is lying flush on the furnace tray.

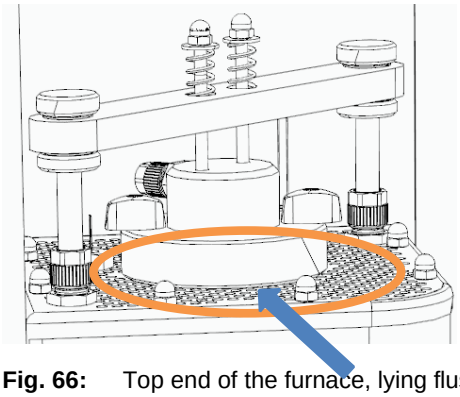


Fig. 66: Top end of the furnace, lying flush

8.5.2 Combustion tube replacement

- Remove the furnace cleaning system – see Chapter 8.5.1.
- Unscrew the wing nuts on the bottom end of the furnace without removing them.

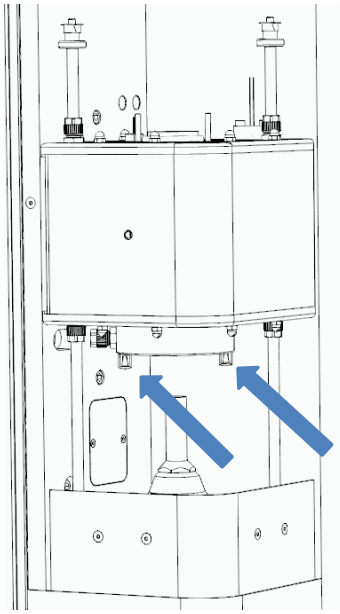


Fig. 67:

- Pull the combustion tube with the O-ring (marked red) out of the furnace.

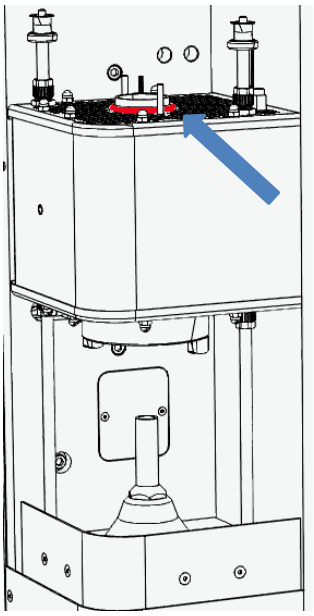


Fig. 68: Combustion tube with o-ring

- Replace the combustion tube and assemble everything in reverse order.

NOTICE

When dismantling the combustion tube, it is worthwhile checking the condition of the O-rings and replacing these where necessary. Refer to the chapter on “Replacing the O-rings”.

- Tighten the wing nuts on the bottom end of the furnace again!

8.5.3 Pedestal removing

CAUTION

The pedestals can be very hot.
Please check whether the pedestal has cooled down and has been cleaned before removing it.

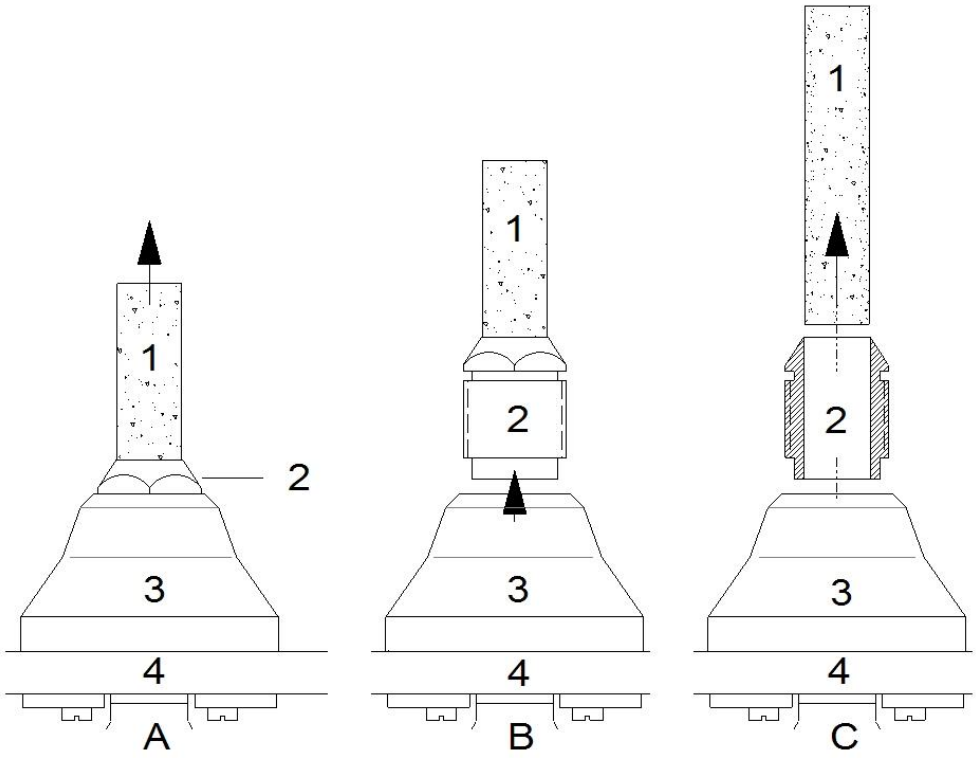


Fig. 69: Removing the pedestal

A Remove the sample stand (1) by lifting from the furnace cone plug.

B If the sample stand can only be lifted with difficulty, unscrew the nut (2) from the cone (3) using a 24-mm spanner.

C In this way you can access the bottom part of the sample stand and can remove it. When placing the nut (2) on the cone (3), ensure that there is no dust in the threads of the two parts. A vacuum cleaner can be used to clean the thread before assembling again.

8.6 O-rings replacement

CAUTION

C32.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.

- **Use heat protecting gloves.**

CAUTION

C33.0062

Injuries in the form of cuts and other personal injuries

Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged sample flasks and glass splitters.

- **Replace damaged sample flasks**
- Do not touch glass splitters with your hands.

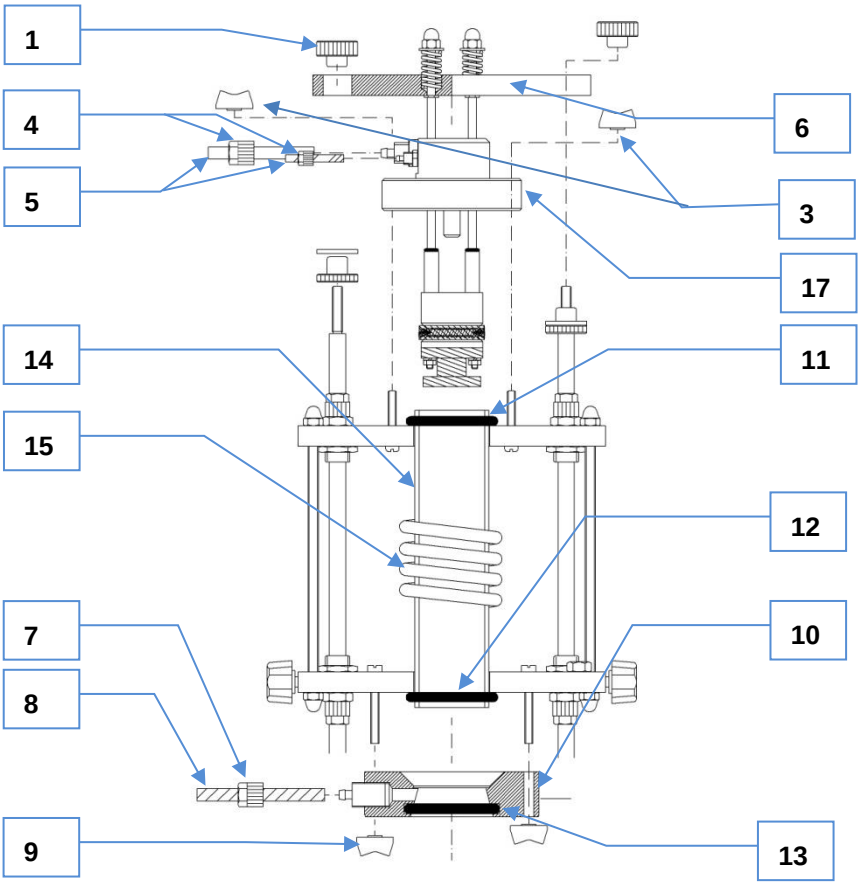


Fig. 70: Detailed view of the furnace

1	Knurled nut
2	NN
3	Wing nuts
4	Nut for gas inlet hose
5	Gas inlet hose
6	Support
7	Nut for gas outlet hose
8	Gas outlet hose
9	Wing nuts
10	Bottom furnace lock
11	Top O-ring for the combustion tube
12	Bottom O-ring for the combustion tube
13	O-ring for the bottom furnace lock
14	Combustion tube
15	Induction coil
16	NN
17	Top furnace lock

8.6.1 Replacing O-rings 11 and 12 for the combustion tube

- Remove the top furnace cover.
- Open the furnace.
- Unscrew the knurled nuts (1).
- Unscrew the wing nuts (3).
- Unscrew the nuts (4) and remove the gas hoses (5).
- Remove the furnace cleaning system by pulling the support (6) upwards.
- Unscrew the nut (7) and remove the hose (8).
- Unscrew the wing nuts (9) and pull the bottom furnace lock (10) downwards.
- It is now possible to remove and replace the O-rings (11) and/or (12). Place a thin layer of grease on the inner surfaces of the new O-rings before attaching them. Put a thin layer of grease on the outer surface of the combustion tube onto which the new O-rings are going to be placed.
- Install the parts again, proceeding in reverse order.

8.6.2 Replacing O-ring 13 for the bottom furnace lock

- Remove the top furnace cover.
- Unscrew the nut (7) and remove the hose (8).
- Unscrew the wing nuts (9) and pull the bottom furnace lock (10) downwards.
- Remove the O-ring (13) using a screwdriver. Insert a new O-ring without greasing it.
- Install the parts again, proceeding in reverse order.

8.6.3 Replacing O-rings 10 for the furnace seal

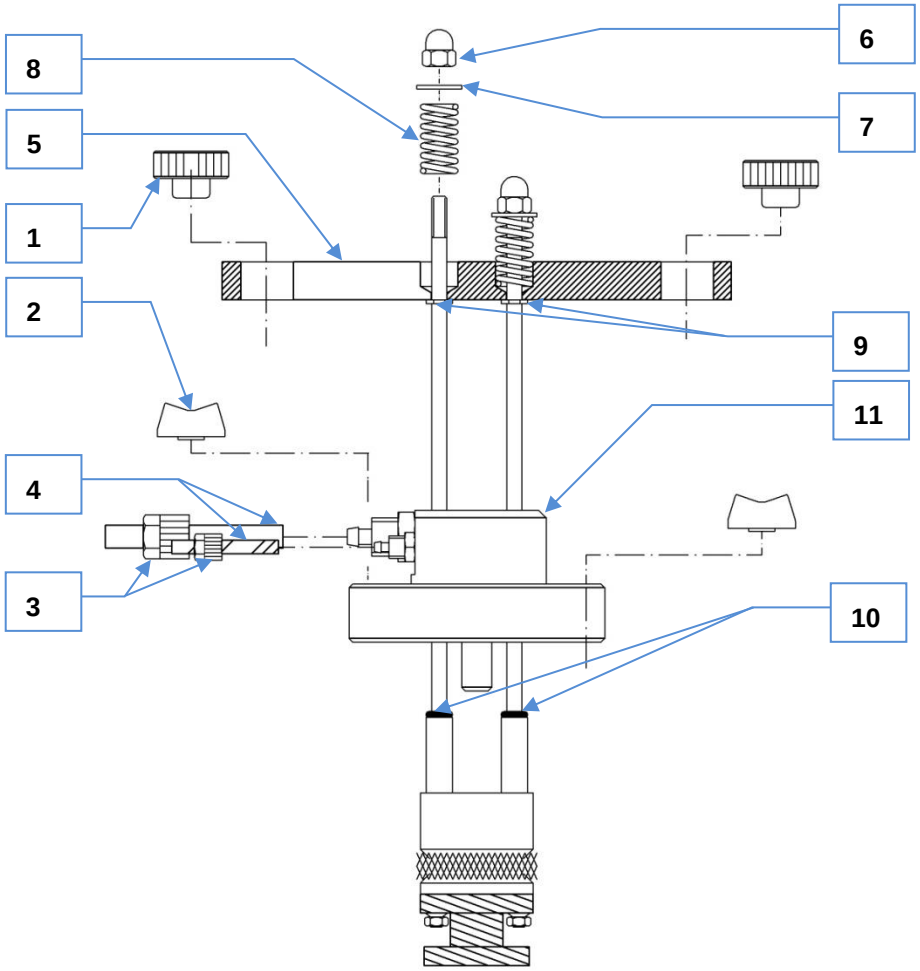


Fig. 71: Detailed view of the cleaning mechanism

- Unscrew the knurled nuts (1).
- Unscrew the wing nuts (2).
- Unscrew the nuts (3) and detach the gas inlet hoses (4).
- Remove the cleaning system of the furnace by pulling the rods (5) upwards.
- Unscrew the nuts (6) and remove the washers (7) and the springs (8).
- Remove the rod (5).
- Remove the circlips (9).
- Remove the top furnace lock (11).
- Remove and replace the O-rings (10). Do not grease the O-rings!
- Install the parts again, proceeding in reverse order.

NOTICE

The O-rings are only replaced when, due to damage or age, they can no longer provide an adequate seal. It is important not to damage the sealing surfaces on connectors when removing the old O-rings. The sealing surfaces of the O-rings on the rods and the inside of the furnace lock (11) must be cleaned so they are free from grease and dust.
These O-rings must not be greased.

NOTICE

After carrying out diverse servicing work, it is worthwhile conducting a leak test. Please refer to Chapter 6.6 “Leak test” for further information.

8.7 Cleaning the connection hose between the furnace and metal filter

- Open the front of the analyzer.
- Unscrew the hose nut on the closing mechanism of the dust filter and pull the hose off.

Fig. 72: Hose connection dust filter / furnace

- Clean the hose using a pipe cleaner (Order No.: 70002) or a microbrush (Order No.: 88400-0501).

NOTICE

During cleaning, it makes sense to start the vacuum cleaner using the software (Analyzer status window, User service) or to remove falling particles using an external vacuum cleaner.

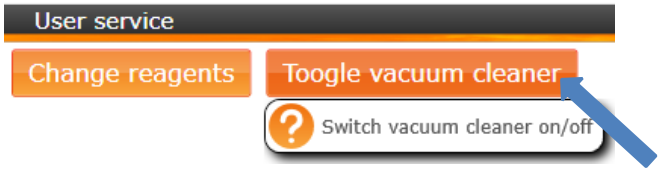


Fig. 73: Switching the vacuum cleaner on / off

8.8 Generator tube replacing

Replacement is not necessary in the normal servicing cycle. If replacement is necessary, however, separate guidelines are available for this: see Chapter 1, Contact information.

8.9 Combustion coil replacing

Replacement is not necessary in the normal servicing cycle. If replacement is necessary, however, separate guidelines are available for this: see e Chapter 1, Contact information.

8.10 Cleaning

⚠ WARNING W13.0029

Danger to life through electric shock

Cleaning with water

- An electric shock can cause burns, cardiac arrhythmia, respiratory arrest, as well as cardiac arrest.

- **The power cable must be unplugged before cleaning the device.**
- **Use a cloth dampened with water for cleaning.**

NOTICE N8.0077

Damage to the housing

Use of organic solvents

- Organic solvents may damage the coating.

- **The use of organic solvents for cleaning the housing is permitted.**

9 Spare parts

9.1 Front panel illustration

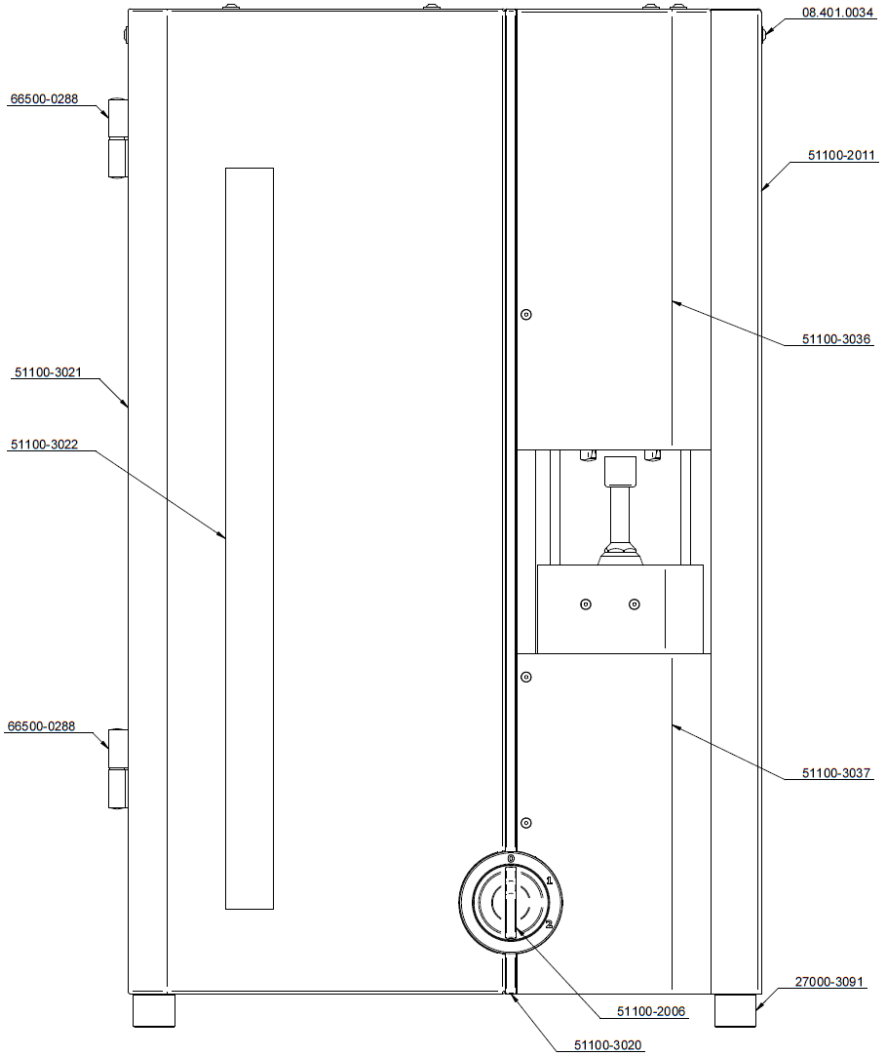


Fig. 74: View of front, closed

Item number	Description	Quantity
08.401.0034	Fillister head screw M6x10	2
27000-3091	Analyser feet	8
51100-2006	Main switch adapter	1
51100-2011	Right-hand device cover	1
51100-3020	Design element	1
51100-3021	Door	1
51100-3022	Door film	1
51100-3036	Top furnace cover	1
51100-3037	Bottom furnace cover	1
66500-0288	Hinge with eccentric pin	2

9.2 Front side (inside view)

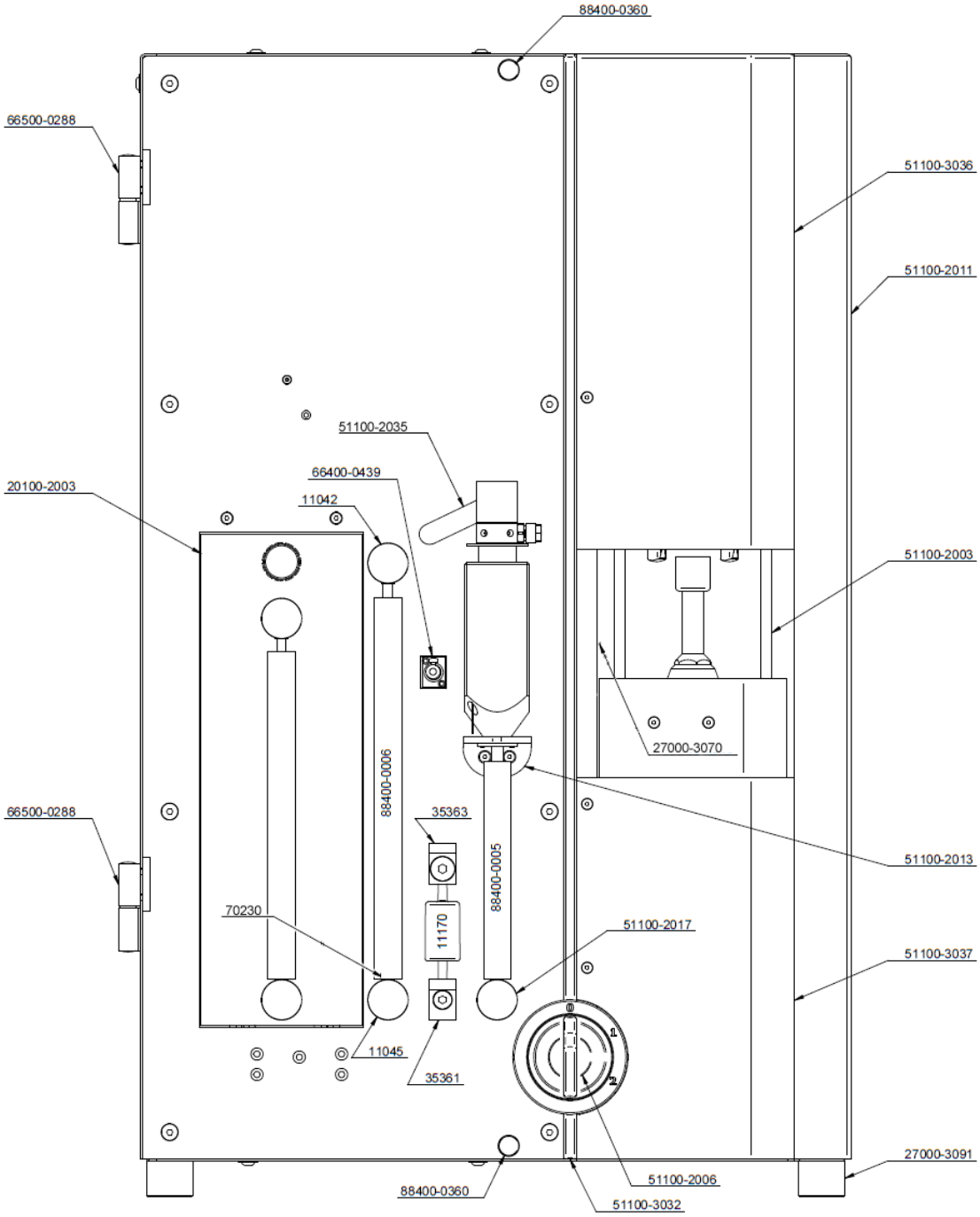


Fig. 75: View of front, inside

Item number	Description	Quantity
11042	Top reagent tube holder, moisture trap	1
11045	Bottom reagent tube holder, moisture trap	1
11170	Dust filter cartridge	1
20100-2003	Complete catalyst furnace	1
27000-3070	Furnace light cover	1
27000-3091	Analyzer feet	8
35361	Bottom filter support	1
35363	Top filter supper	1
51100-2003	Complete furnace	1
51100-2006	Main switch adapter	1
51100-2011	Right-hand device cover	1
51100-2013	Filter connection support, installed	1
51100-2017	Reagent tube holder 28.5mm	1
51100-2035	Dust filter housing with heating element, complete	1
51100-3032	Design element	1
51100-3036	Top furnace cover	1
51100-3037	Bottom furnace cover	1
66400-0439	3-pin connector mini XLR	1
66500-0288	Hinge with eccentric pin	2
70230	O-ring 9x3	6
88400-0005	Reagent tube	1
88400-0006	Reagent tube	1
88400-0360	Disc magnet Ø15x3	2

9.2.1 Catalyst furnace

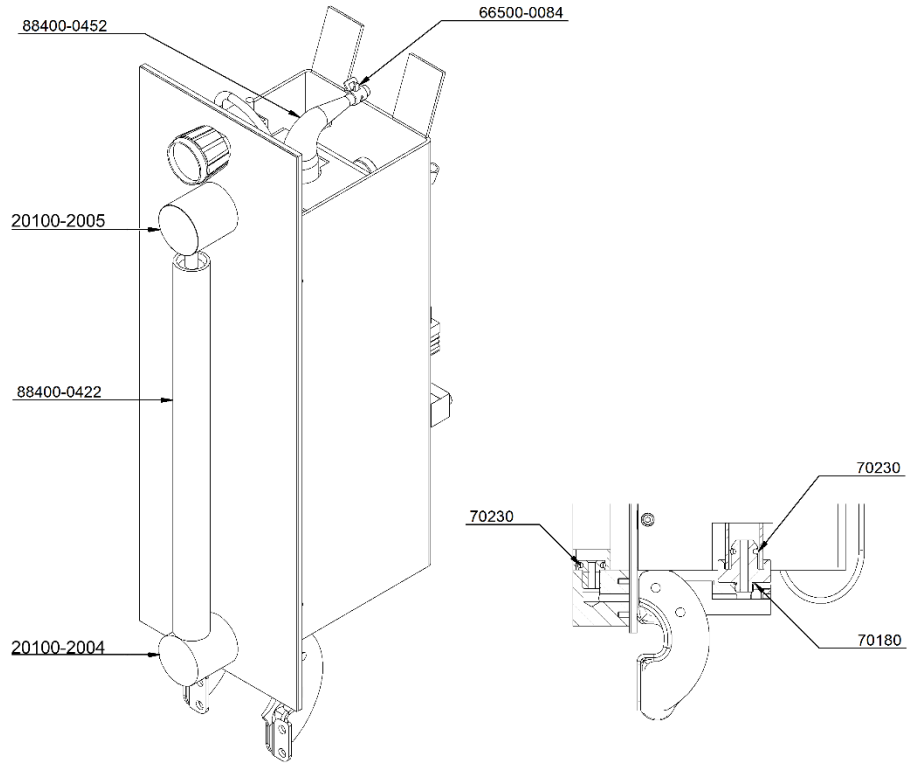


Fig. 76: Catalyst furnace 20100-2003

Item number	Description	Quantity
20100-2004	Bottom reagent tube holder, catalyst furnace	1
20100-2005	Top reagent tube holder, catalyst furnace	1
66500-0084	Hose clamp/clip	1
70180	O-ring 8x1.5 for 20100-2003, catalyst furnace	1
70230	O-ring 9x3	2
88400-0422	Reagent tube 240x20/16.4	1
88400-0452	Quartz tube	1

9.2.2 Complete dust filter housing with heating element

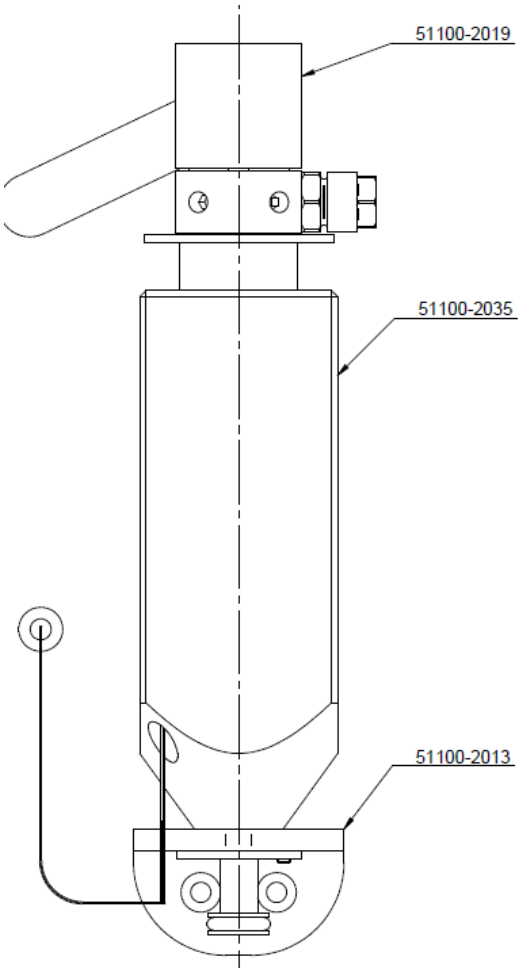


Fig. 77: Complete dust filter housing 51100-2035

Item number	Description	Quantity
51100-2013	Filter connection support	1
51100-2019	Dust trap mechanism	1
51100-2035	Complete dust filter housing with heating element	1

9.2.2.1 Complete dust filter

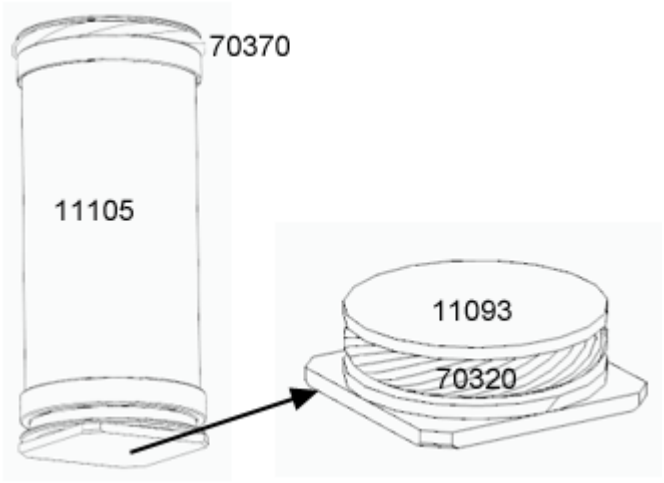
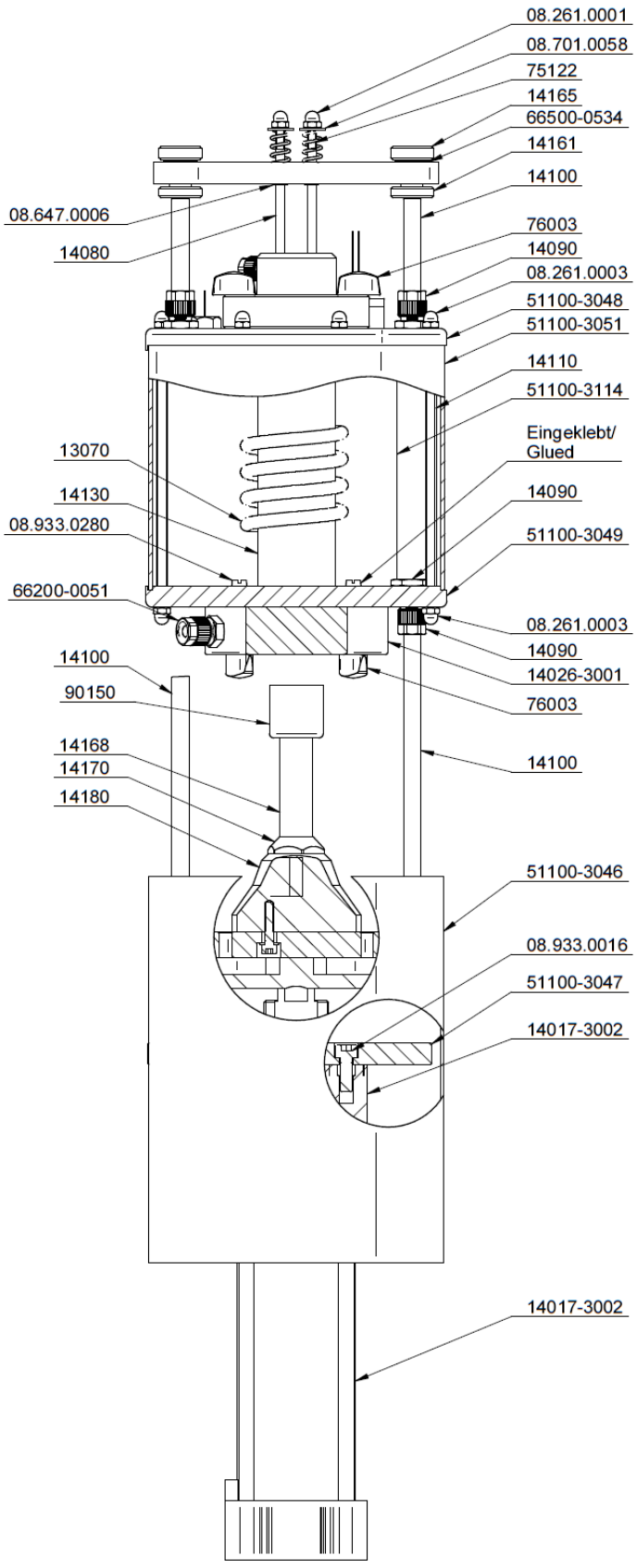


Fig. 78: Dust filter 11107

Item number	Description	Quantity
11093	Filter lock	1
11105	Metal filter	1
11107	Complete dust filter	1
70230	O-ring 9x3	1
70320	O-ring 20x5	1

9.3 Furnace



Item number	Description	Quantity
90149	Crucible	1000
76003	Wing nut	4
75122	Spring	2
66500-0534	Roller bearing with flange GFM-1112-06	2
66200-0051	Straight screw-in connection	1
51100-3114	Spacer tube	2
51100-3051	Furnace cover	1
51100-3049	Bottom furnace tray	1
51100-3048	Top furnace tray	1
51100-3047	Cylinder support	1
51100-3046	Cylinder panel	1
14180	Cone	1
14170	Pedestal foot	
14168	Pedestal	1
14165	Top knurled nut	2
14161	Bottom knurled nut	2
14130	Combustion tube	1
14110	Threaded rod	6
14100	Shaft	2
14090	Furnace bearing bushing	2
14080	Mounting bar	2
14026-3001	Bottom end of the furnace	1
13070	Combustion coil	1
08.933.0280	Cylinder screw	2
08.933.0016	Cylinder screw	4
08.701.0058	Washer	2
08.647.0006	Circlip	2
08.261.0003	Cap nut	12
08.261.0001	Cap nut M4-A2	2

Fig. 79: Furnace, view from the front 1

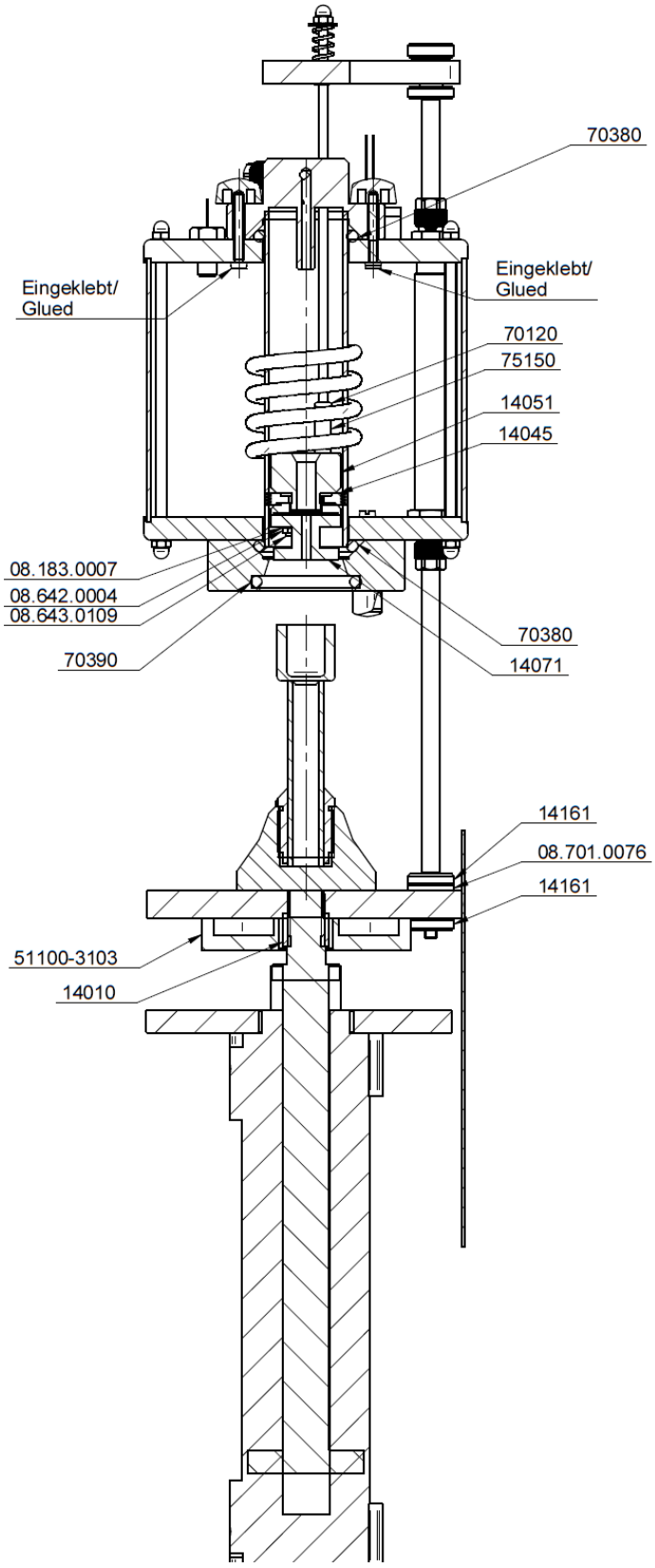


Fig. 80: Furnace, view from the front 2

Item number	Description	Quantity
08.183.0007	Serrated washer	2
08.642.0004	Hex nut M3	2
08.643.0109	Countersunk screw	2
08.701.0076	Washer	4
14010	Spacer	1
14045	Cleaning brush	1
14051	Brush support	1
14071	Heat protection, ceramic	1
14161	Bottom knurled nut	4
51100-3103	Suction	1
70120	O-ring 3.4x1.9	2
70380	O-ring 35x5	2
70390	O-ring 35x5	1
75150	Spacer sleeve M4	2

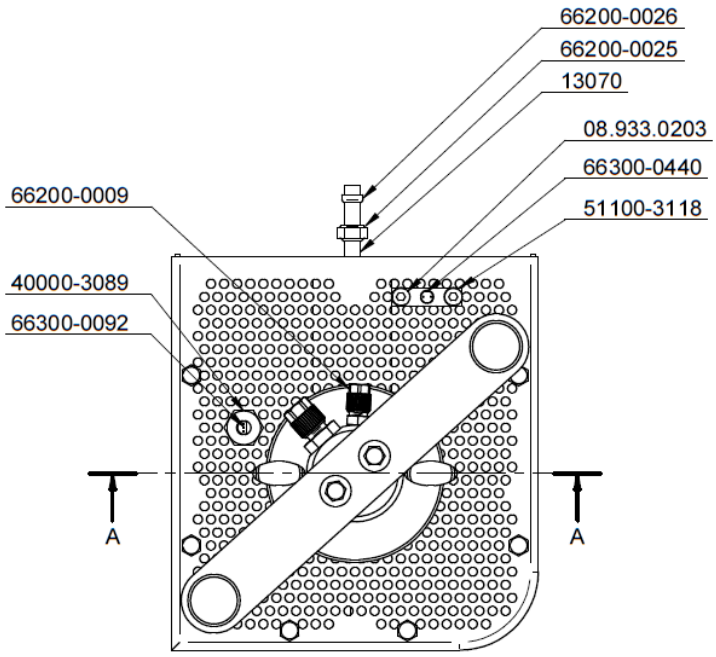


Fig. 81: Furnace, plan view

Item number	Description	Quantity
08.933.0203	Cylinder screw M4x18	2
13070	Coil	1
40000-3089	Hexagon screw M8x16	1
51100-3118	Light sensor fastening	1
66200-0009	Straight screw-in connection	1
66200-0025	Cap nut 1/8"	2
66200-0026	Squeezing ring	2
66300-0092	LM335	1
66300-0440	Light sensor	1

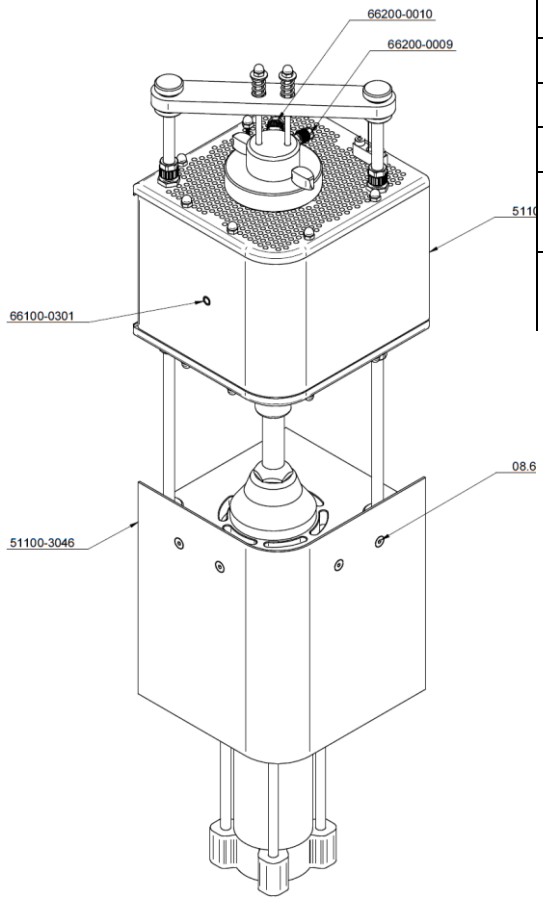


Fig. 82: Furnace, view from the front 3

Item number	Description	Quantity
08.643.0055	Countersunk screw M4x10	4
51100-3046	Cylinder panel	1
51100-3051	Furnace cover	1
66100-0301	Blind rivet M4	1
66200-0009	Straight screw-in connection	1
66200-0010	Straight screw-in connection	1

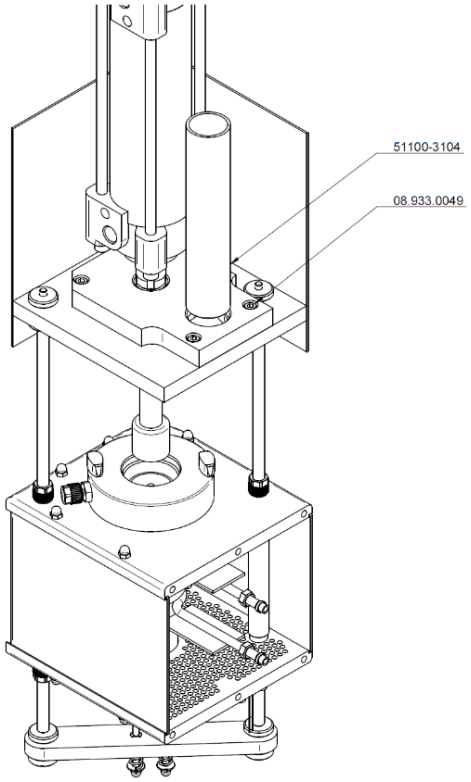


Fig. 83: Furnace, view from below

Item number	Description	Quantity
08.933.0049	Cylinder screw M5x16	4
51100-3104	Tube 30x2x150	1

9.4 Furnace cleaning mechanism

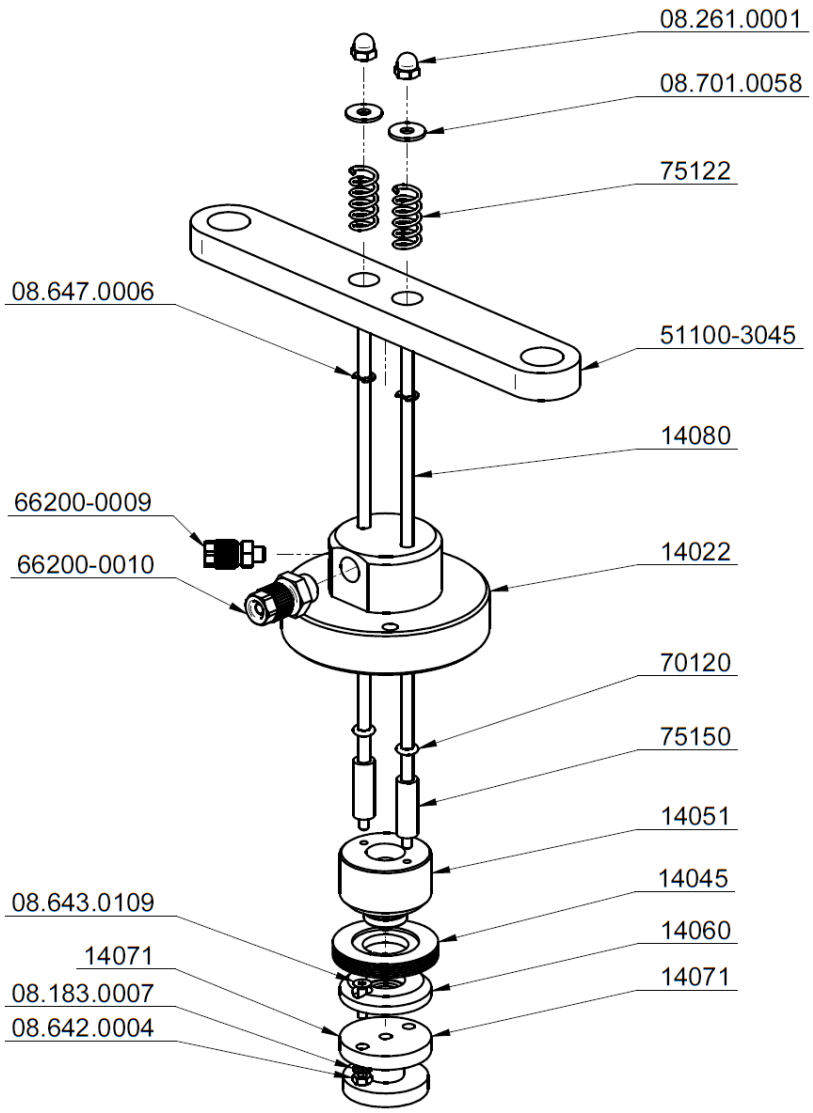


Fig. 84: Order numbers, furnace cleaning mechanism

Item number	Description	Quantity
08.183.0007	Serrated washer A3.2-A2	2
08.261.0001	Cap nut DIN 1587-M4-A2	2
08.642.0004	Hex nut M3-A2	2
08.643.0109	Countersunk screw M3x12	2
08.647.0006	Retaining washer DIN 6799 3.2 -H45	2
08.701-0058	Washer 4.3 DIN 9021-A2	2
14022	Top furnace lock	1
14045	Cleaning brush for the combustion tube	1
14051	Brush holder	1
14060	Brush ring	1

Item number	Description	Quantity
14071	Ceramic part, heat protection	1
14072	Complete ceramic heat protection for the brush	1
14080	Mounting rod	2
51100-2004	Complete furnace cleaning mechanism	1
51100-3045	Top flat steel	1
66200-0009	Straight screw-in connection M5	1
66200-0010	Straight screw-in connection G1/8"	1
70120	O-ring 3.4x1.9	2
75122	Spring	2
75150	Spacer sleeve	2

9.5 Back side illustration

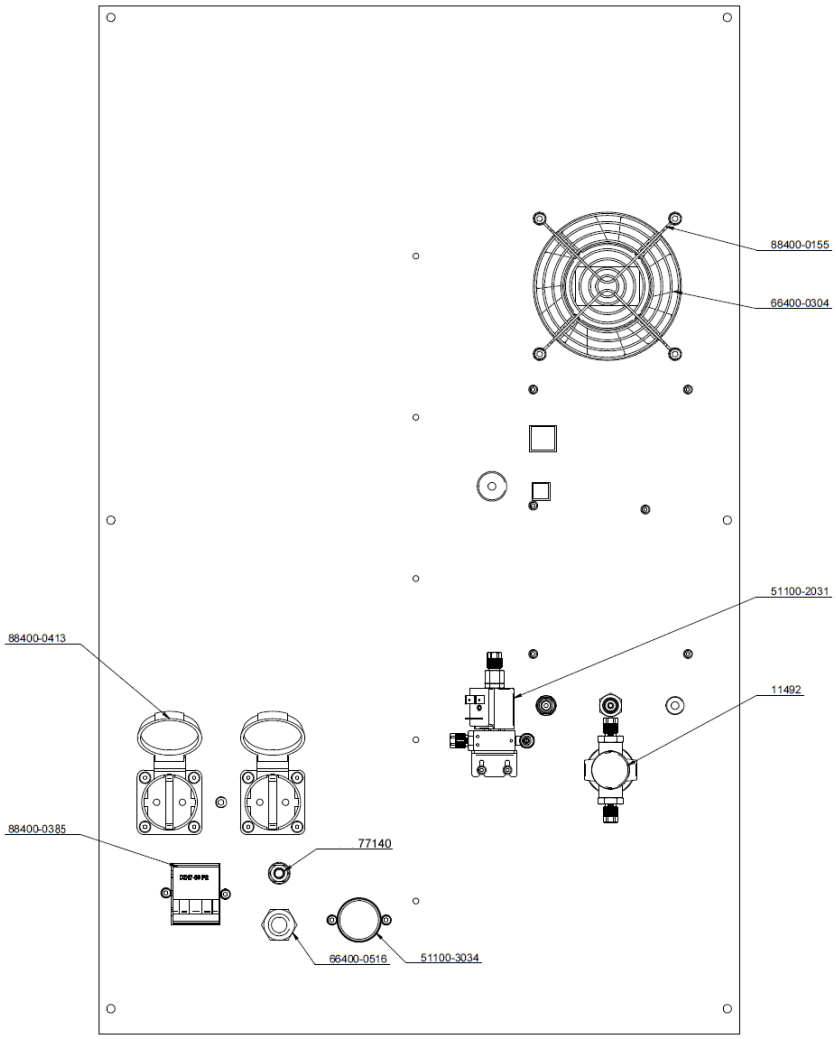


Fig. 85: Order numbers, back

Item number	Description	Quantity
11492	O_2 pressure controller	1
51100-2031	Gas valve	1
51100-3034	Vacuum cleaner adapter	1
66400-0304	Fan 24V	1
66400-0516	Cable routing PG13	1
77140	Mains filter 250V / 16A	1
88400-0155	Fan grille 120x120	1
88400-0385	Circuit breaker 2P 16 AC	1
88400-0413	Socket SCHUKO	2

9.6 Left side illustration

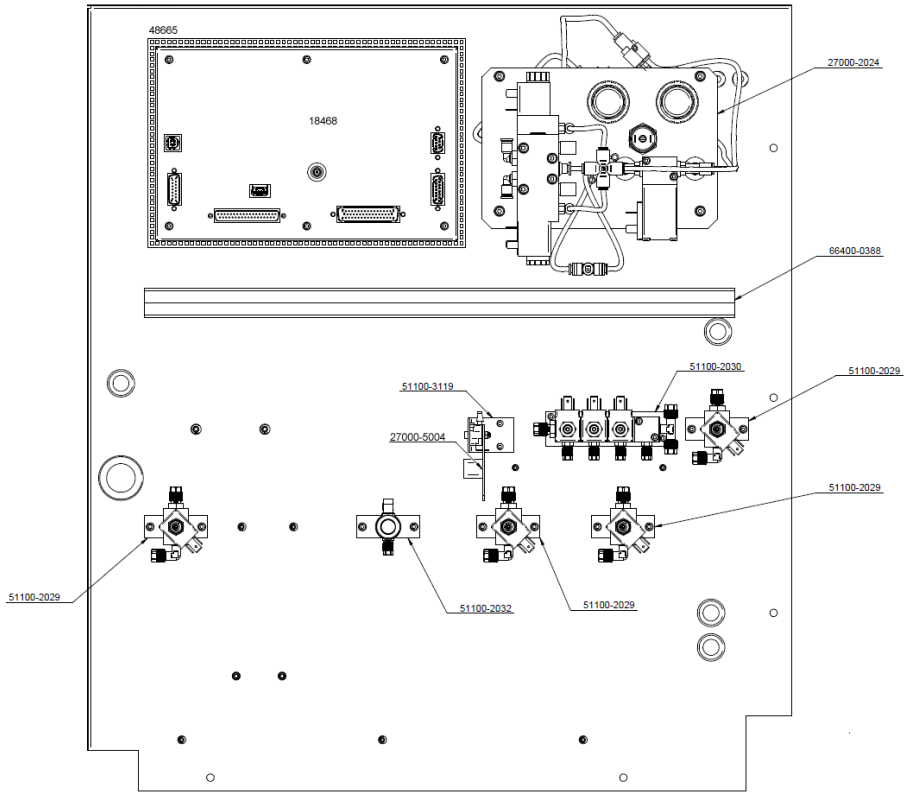


Fig. 86: Left-hand side

Item number	Description	Quantity
18468	Uni 2.x with housing	1
27000-2024	Complete compressed air control	1
27000-5004	PCB pressure sensor	
48665	Complete support of Uni circuit board	1
51100-2029	Complete gas valve	4
51100-2030	Valve manifold	1
51100-2032	Complete control valve	1
51100-3119	Support for pressure sensor	
66400-0388	Cable duct 25x25	1

9.6.1 Left-hand side, Dev Gate

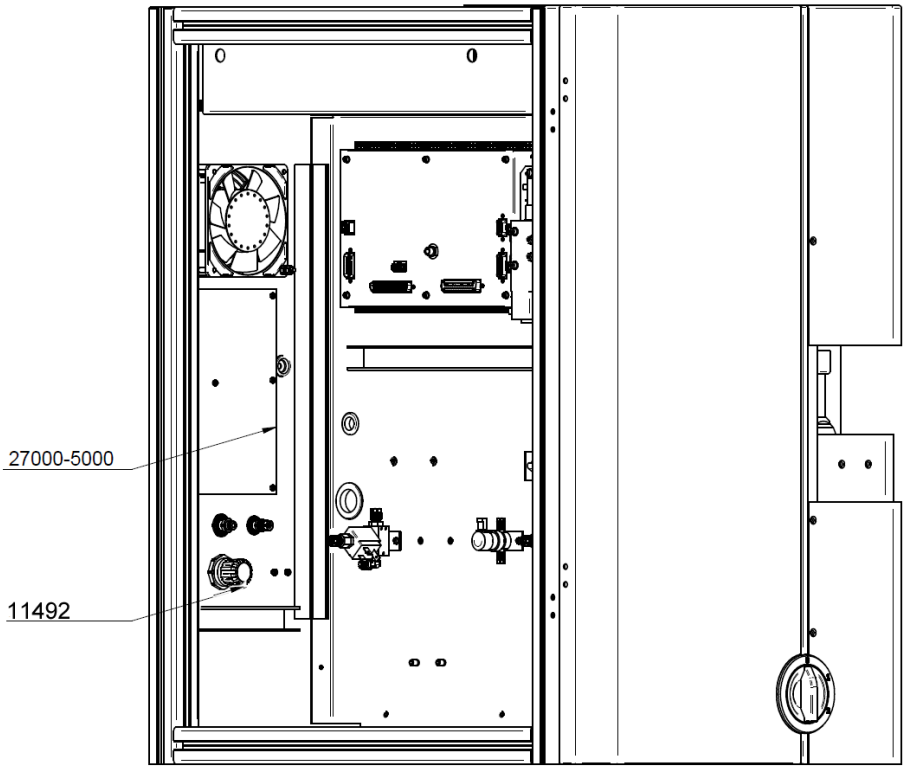


Fig. 87: DevGate

Item number	Description	Quantity
11492	Incoming pressure controller	1
27000-5000	PCB DevGate	1

9.6.2 Valve manifold, compressed air control

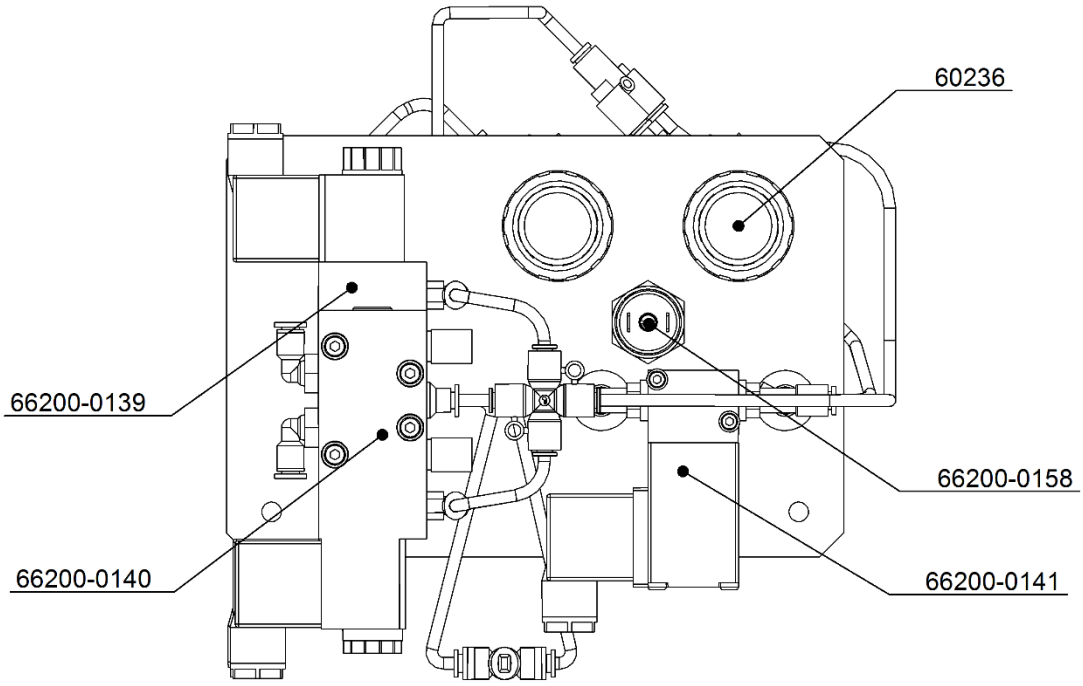


Fig. 88: Valve manifold, compressed air control 27000-2024

Item number	Description	Quantity
60236	Pressure controller	2
66200-0139	Valve, 5/3 way	1
66200-0140	Valve, 5/2 way	1
66200-0141	Valve, 2/2 way	1
66300-0158	Pressure switch	1

9.7 Spare parts IR-cell

9.7.1 IR-path, long

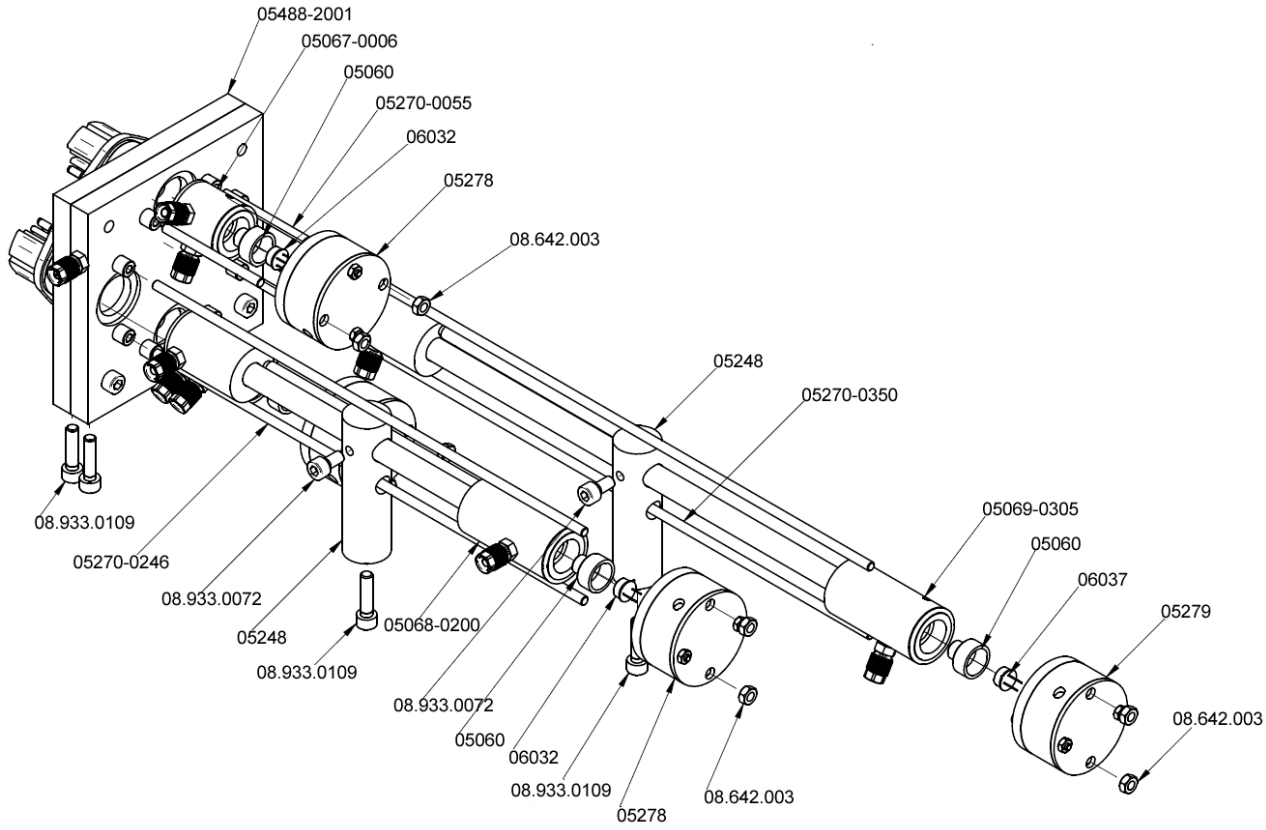


Fig. 89: IR-path, long

Item number	Description	Quantity
05060	Reflector	4
05067-0006	IR-path 6mm, complete	1
05068-0200	IR-path 200mmA	1
05069-0305	IR-path 305mmA	1
05248	IR-path holder	2
05270-0246	Threaded rod M4x246	2
05270-0350	Threaded rod M4x350	2
05278	Preamplifier, 3-pin, complete	3
05279	Preamplifier, 3-pin, complete	1
05488-2001	Chopper assembled	1
06032	CO_2-Detektor, 3-pin	2
06037	SO2-Detector, 4 -pin	1
08.642.0003	Hexagon nut M4-A2	10
08.933.0072	Cylinder head screw M5x10	2
08.933.0109	Cylinderhead screw M5x20-A2	8

9.7.2 IR-path, short

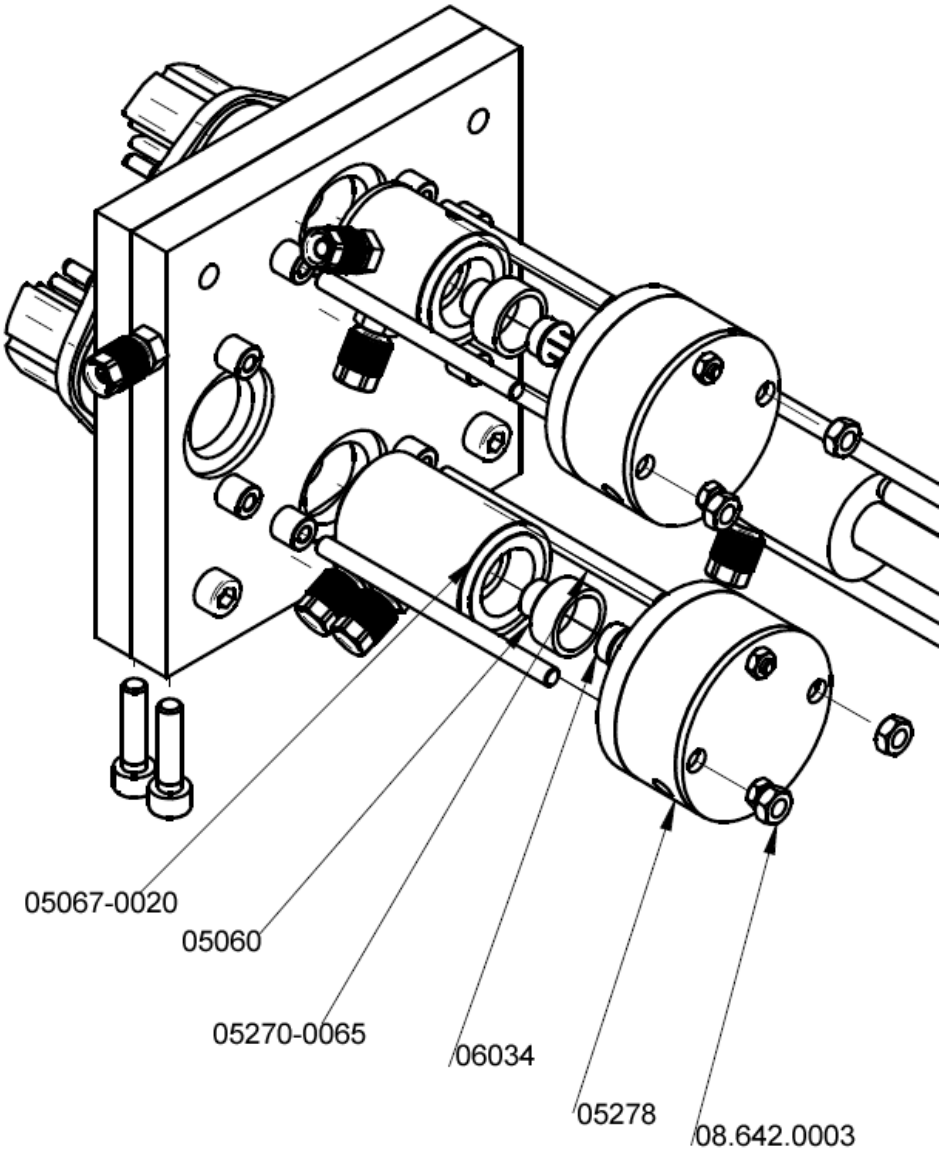


Fig. 90: IR-path short 05488-2001

Item number	Description	Quantity
05060	Reflector	4
05067-0020	IR-path 20 mm, complete	1
05270-0065	Threaded rod M4x55	2
05278	Preamplifier, 3-pin, complete	3
06034	SO2-Detector, 3 -pin	1
08.642.0003	Hexagon nut M4-A2	10

9.7.3 Chopper Motor

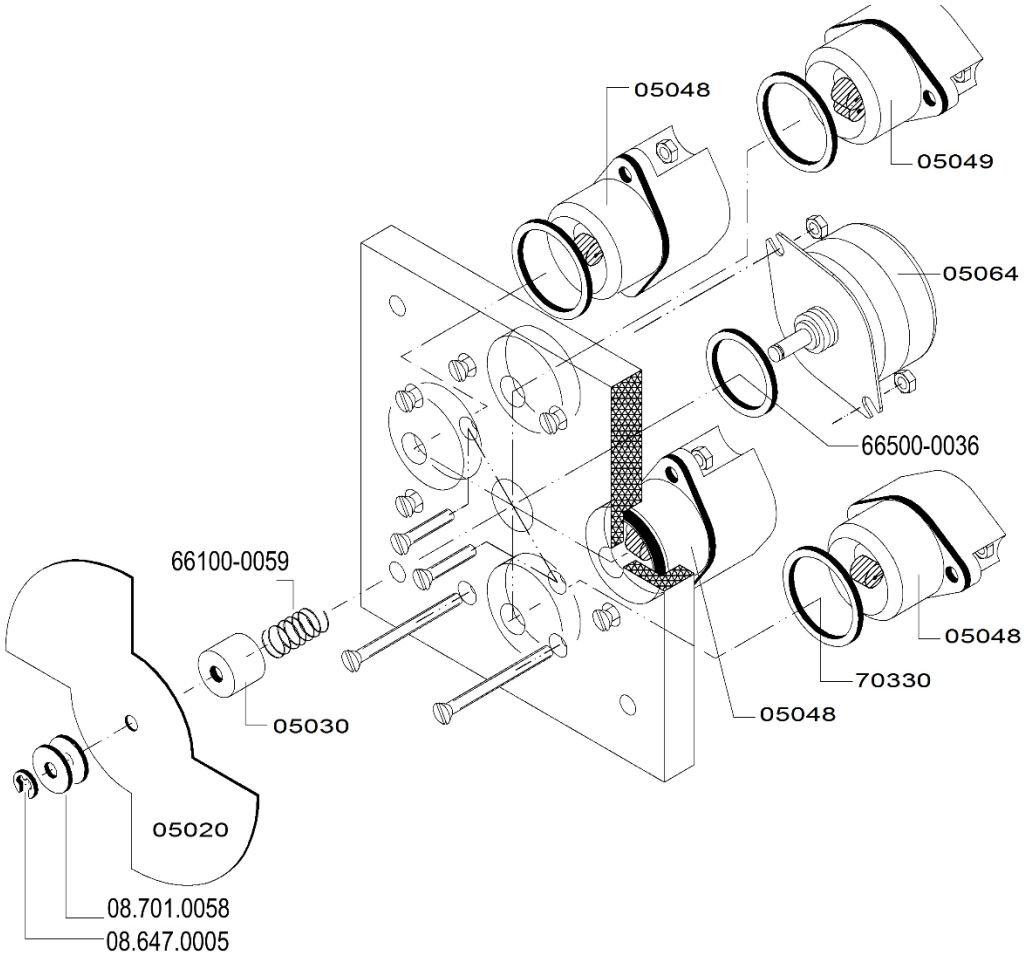


Abb. 91: Chopper motor 05488-2001

Item number	Description	Quantity
05020	Chopper blade	1
05030	Chopper blade holder	1
05048	Infrared source (emitter)	3
05049	Infrared source (emitter), double	1
05064	Chopper blade motor	1
05488-2001	Chopper motor complete, assembled	1
08.647.0005	Retaining washer	1
08.701.0058	Washer DIN9021	2
66100-0059	Spring	1
66500-0036	O-Ring, 18x2	1
70330	O-Ring, 21x2	3

Caution!
Important information!

The data in the following section is purely informative, and does not represent any call to action.

All work on the components shown may only be performed by appropriately qualified service staff. The voltage range is 10 kV.

A special tool (Article No. 1101-2005) is required to discharge the oscillating circuit.

ELTRA Service must be contacted before opening the right-hand side of the device to carry out the work on that side.

DANGER

D3.0005

Mortal danger from electric shock
Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

9.8 Right side illustration

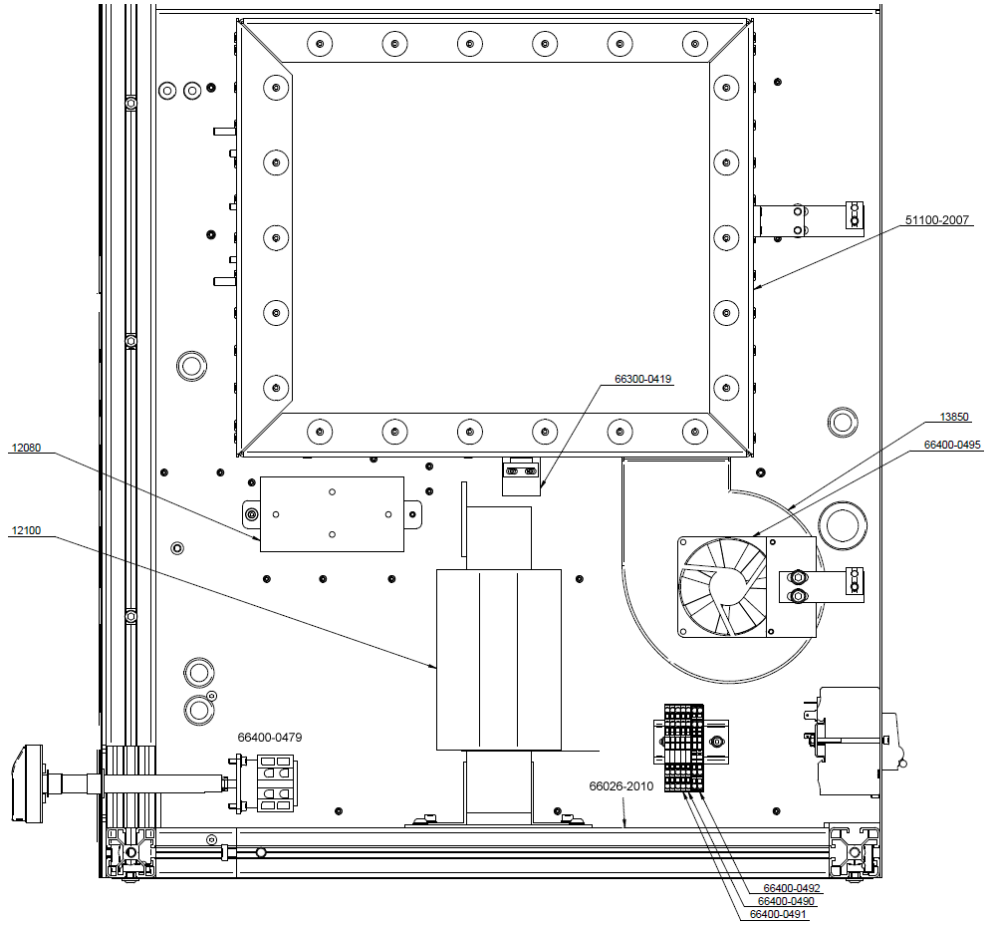


Fig. 92: Right-hand side

Item number	Description	Quantity
12080	Rectifier	1
12100	High voltage transformer	1
13850	Fan	1
51100-2007	Oscillator housing	1
66026-2010	Throttle valve	1
66300-0419	Safety switch	1
66400-0479	Main switch 25A	1
66400-0490	Wago clamp 2001-1401, grey	2
66400-0491	Wago clamp 2001-1404, blue	3
66400-0492	Wago clamp 2001-1407, green	2
66400-0495	Fan 80x80x25	1

9.8.1 Oscillating circuit

DANGER

D4.0005

Mortal danger from electric shock

Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

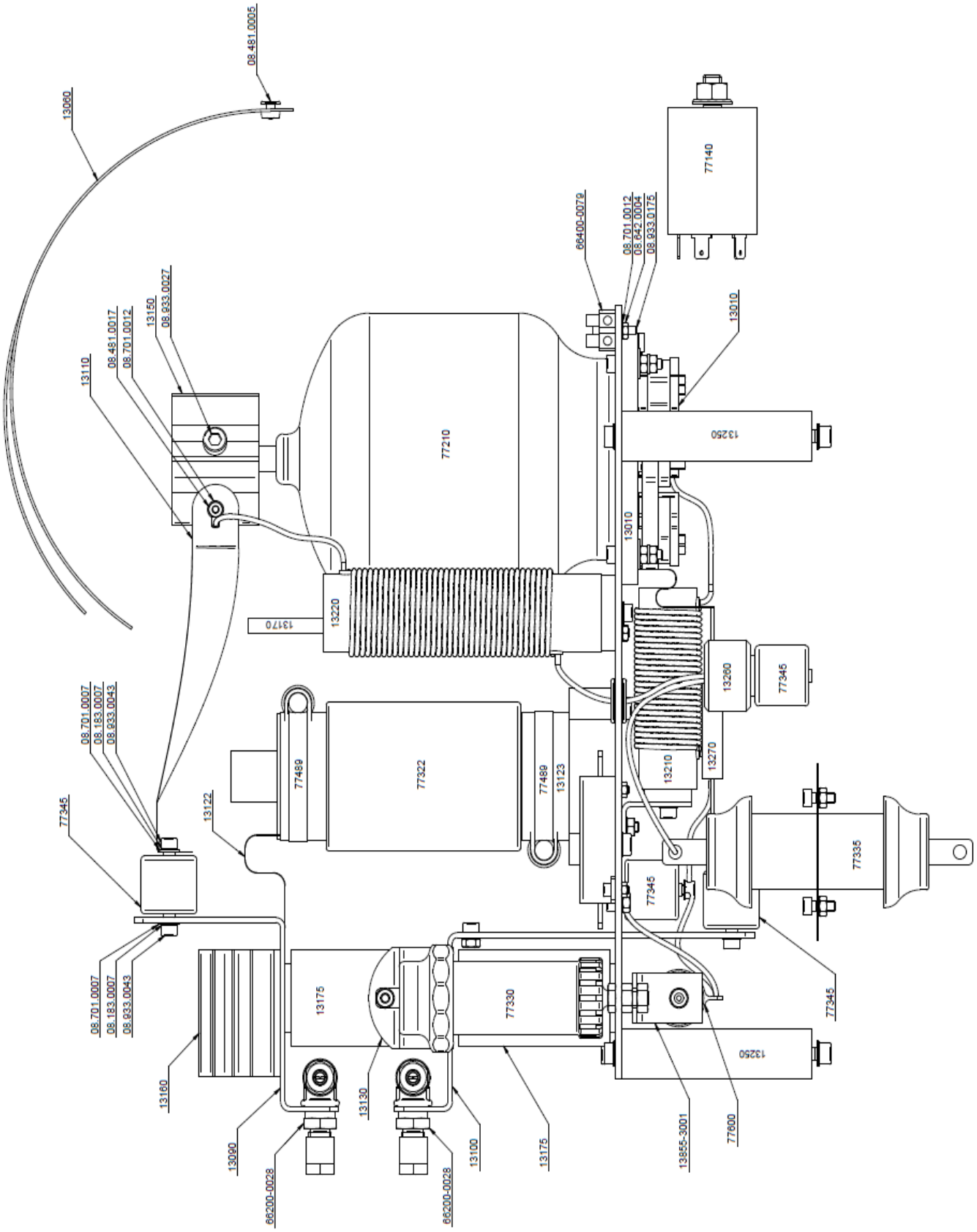


Fig. 93: Order numbers, oscillating circuit

Item number	Description	Quantity
08.183.0007	Serrated washer A3.2-A2	2
08.481.0005	Blind rivet A-4x8-Al	2
08.481.0017	Blind rivet A-3x8-Al	1
08.642.0004	Hex nut M3-A2	1
08.701.0007	Washer A3.2-A2	2
08.701.0012	Washer A3.2-A2	2
08.933.0027	Cylinder screw M6x20-A2	1
08.933.0043	Cylinder screw M4x10	2
08.933.0175	Cylinder screw M3x16	1
12855-3001	Mounting bracket	2
13010	Complete tube socket	1
13060	Guard plate	1
13090	Top coil terminal	1
13100	Bottom coil terminal	1
13110	Anode connection	1
13122	Top capacitor connection, installed	1
13123	Bottom capacitor connection, installed	1
13130	Capacitor connection	1
13150	Anode heat sink	1
13160	Coil heat sink	1
13170	Radiation protection	1
13175	Isolator	1
13210	Grid resistor	1
13220	Anode resistor	1
13250	Housing support device	4
13260	High voltage filter	1
13270	Cement resistor	1
66200-0028	Straight screw in connection G 1/8	2
66400-0079	Screw terminal, 4 connections	1
77140	HF-Filter, 250V / 16 A	1
77210	Generator tubes	1
77322	Capacitor	1
77330	Capacitor	1
77335	Capacitor	1
77345	Capacitor	4
77489	Retaining bracket	2
77600	Resistor	1

9.9 Top mounting panel

DANGER

D5.0005

Mortal danger from electric shock

Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

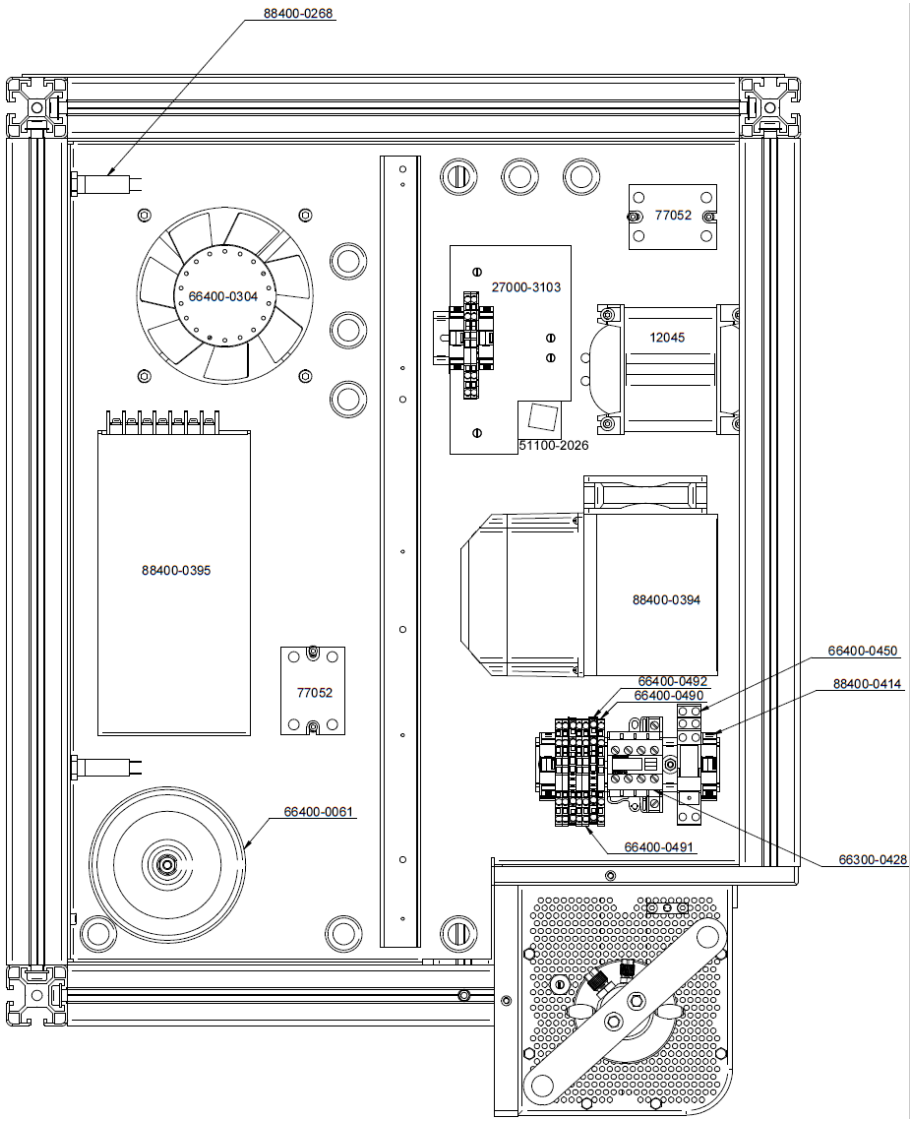


Fig. 94: Top mounting panel

Item number	Description	Quantity
12045	Transformer	1
27000-3103	Circuit board guard	1
51100-2026	PCB board	1
66300-0428	Mini-contactor 24VDC 4 NO	1
66400-0061	Toroidal transformer catalyst furnace	1
66400-0304	Fan, furnace cooling, 24V	1
66400-0450	Coupling relay 2 changeover contacts 8A. 24VDC	1
66400-0490	Wago clamp 2001-1401, grey	4
66400-0491	Wago clamp 2001-1404, blue	3
66400-0492	Wago clamp 2001-1407, green	2
77052	Semi-conductor relay 40A	2
88400-0268	Safety switch	2
88400-0394	Maxthermo power controller	1
88400-0395	Power supply unit	1
88400-0414	End terminals for terminal strips	4

9.10 Oxygen purification furnace, optional

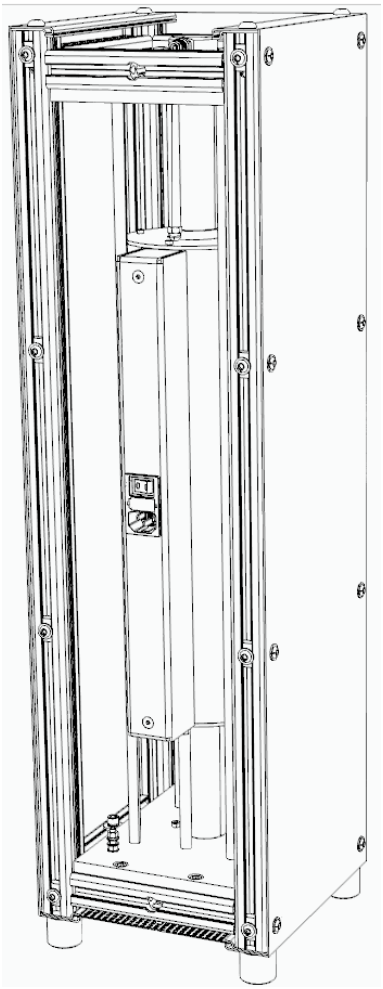


Fig. 95: Complete oxygen purification furnace

Item number	Description	Quantity
21000-1001	Complete oxygen purification furnace	1
21120	Quartz tube	1
70380	O-ring 35x5	2
88400-0122	Filling for oxygen purification furnace (CS)	1

9.11 Fuses

Item number	Description	Quantity
66300-0369	6.3A safety fuse for 27000-5000 DevGate board and 27000-5001 PCB furnace power control	2
66300-0410	3.15A safety fuse for top mounting panel	1

9.12 Consumables

Item number	Description	Quantity
90149	Crucible	1000 pcs.
90200	Anhydrone	454g
90210	Sodium hydroxide	500g
88400-0535	Pt/Si	15g
90330	Quartz wool	50g
90332	Glass wool	50g

10 Approved methodologies to which Eltra instruments conform

10.1 Inorganic materials (Metals)

Norm	Elements	Materials	Instruments
DIN EN ISO 9556:2002-04	C	Steel and Iron	CSi CSd
ISO 4935:1989 DIN EN 24935:1992-07	S	Steel and Iron	CSi CSd
ASTM E 1019:2011	C, N, O, S	Steel, Iron, Nickel / Cobalt Alloys	CSi CSd ON-p OH-p ONH-p
ASTM E 1587:2010	C, N, O, S	Refined Nickel	CSi CSd ON-p OH-p ONH-p
ASTM E 1409:2013	N, O	Titanium and Titanium Alloys	ON-p OH-p ONH-p
ASTM E 1569:2009	O	Tantalum	ON-p OH-p ONH-p
ASTM E 1447:2009	H	Titanium and Titanium Alloys	OH-p ONH-p
ASTM E1915 - 13	C, S	Metal Bearing Ores and Related Materials (i.e. tailings, waste rock)	CS-580 CSi CSd
UOP703 - 09	C	Catalysts	CSi CSd
ASTM E 1941:2010	C	Refractory and Reactive Metals	CSi CSd
ASTM E2575 - 08	O	Copper	ONH-p
DIN EN ISO 15351	N	Steel	ONH-p ON-p
ISO 22963	O	Titan	ONH-p serie
ISO 17053	O	Steel/Iron	ONH-p serie
DIN EN ISO 15349-2	C	Steel	CSi CSd

ISO 13902	S	Steel/Iron	CSi CSd
ISO 4689-3	S	Iron ore	CSi CSd
ISO 7524	C	Nickel	CSi CSd
DIN EN 27526	S	Nickel	CSi CSd
DIN EN ISO 15350	C, S	Steel / Iron	CSi CSd
DIN EN ISO 3690	H	Steel	H 500
DIN EN ISO 10720	N	Steel	ON-p ONH-p
ISO 10719	C	Steel	CSi CSd

10.2 Organic materials (Oil, Coal, foodstuffs)

Norm	Elements	Materials	Instruments
ASTM D 1552:2008	S	Oil and Petrolium Products	CS-580 CSd
ASTM D 4239:2013;	S	Coal and Coke	CS-580 CSd
ASTM D 5016:2008	S	Coal and Coke Ash	CS-580 CSd
ASTM D 1619:2011	S	Carbon Black	CS-580 CSd
DIN EN 13137:2001-12	C	Waste	CS-580 CSd
DIN ISO 10694:1996-08	C	Soil samples	CS-580 CSd
ASTM D 7348:2013	Loss On Ignition (LOI)	Combustion Residues	TGA
ISO 15178	S	Soil	CS 580 CSi CSd

11 Disposal

In the case of a disposal, the respective statutory requirements must be observed. In the following, information on the disposal of electrical and electronic devices in the European Community are given.

Within the European Community the disposal of electrically operated devices is regulated by national provisions that are based on the EU Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE).

Accordingly, all devices supplied after August 13th 2005 in the business-to-business area, to which this product is classified, may no longer be disposed of with municipal or household waste. To document this, the devices are provided with the disposal label.

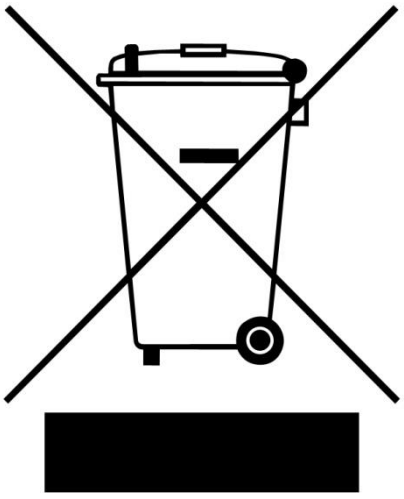


Fig. 1: Disposal label

Since the disposal regulations worldwide and also within the EU may differ from country to country, the supplier of the device should be consulted directly in case of need.

This labelling obligation is applied in Germany since March 23rd 2006. From this date on, the manufacturer must provide an adequate possibility of returning all devices delivered since August 13th 2005. For all devices delivered before August 13th 2005 the end user is responsible for the proper disposal.

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