testo REXS

User Manual

Content

1 Declaration of Warranty

Manual Version History:
Version: V4.0
Date: November 2016

1.1. Type of Designation

This user manual refers to the instrument type and version as listed below. It replaces all previously dated user manuals for this instrument.
Type: testo REXS

1.2. Manufacturer

Testo SE & Co. KGaA
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1.3. Warranty

Testo SE & Co. KGaA warrants that this product adheres to the specified properties for a period of twelve (12) months from the date of delivery.

Excluded from the warranty are all parts subjected to normal wear as any fuses, batteries or other consumable parts. Also excluded are: Defects resulting from abnormal use, in particular outside the intended purpose; lack of maintenance; improper use or malicious damage. Warranty is void if actions are carried out which are not described in the documentation nor authorized by Testo SE & Co. KGaA.

Testo SE & Co. KGaA does not provide any warranty on finished goods manufactured by others. Only the original manufacturer's warranty applies.

There are no user-serviceable parts inside testo MD19-3E and some very sensitive parts. Do not open your testo MD19-3E, as you may damage it. Warranty is voided if the case is opened and warranty-seal is broken.

Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment.

2 Precautions

2.1. Foreword

This manual guides you through the installation, starting up, operation and maintenance procedures of the testo REXS. In detail you will find information about the system as

- safety
- functionality of the testo REXS, technical information and specifications
- installation of the testo REXS and accessories
- handling, operation, maintenance and troubleshooting

The instrument is not intended to be operated alone but integrated into a test stand for filters or particle filter in industrial production and development. Therefore the documentation and manual is not addressed to the end user but rather to the test stand manufacturer. The test stand manufacturer has to generate a self contained user manual.

Follow the instructions provided by this manual for safe and proper operation of the testo REXS soot aerosol generator.

Before installing and operating the testo REXS, the operator or service technician has to read and follow carefully this manual. For improper function, damages or injuries caused by ignoring the instructions by this manual no liabilities are accepted.

2.2. Liabilities

Testo SE & Co. KGaA accepts no liability to improper function or injury caused by

- neglecting the instructions provided by this manual or instructed person
- improper installation, operation, application, or maintenance
- operation by untrained staff
- any technical modification not carried out by Testo SE & Co. KGaA or an authorized service partner
- use of not genuine spare parts

The content of this manual is generated with most accurateness. Testo SE & Co. KGaA does not guarantee completeness, correctness and being up to date. Testo SE & Co. KGaA reserves the right to revise the content of the manual at any time and without notice.

Follow the guidelines below to ensure proper operation of the instrument:

- read this instruction manual before installation and operation
- always use gas of specified quality and purity (propane and nitrogen) when operating this aerosol generator
- make sure that the compressed air supply pressure and gas never exceeds 8 bar
- make sure that the maximum pressure at the compressed air inlet is always less than 8 bar, for propane and nitrogen less than 5 bar
- do not restrict the aerosol outlet. The aerosol generator can only work against pressure up to 500 mbar above atmospheric pressure
- always use genuine replacement parts supplied by Testo SE & Co. KGaA
- allow the instrument to cool off before performing any maintenance at the instrument

2.3. Copyright ©

3 Safety

3.1. Risk Types

The following diagram shows typical risks that could cause damage or injury while handling the testo REXS.

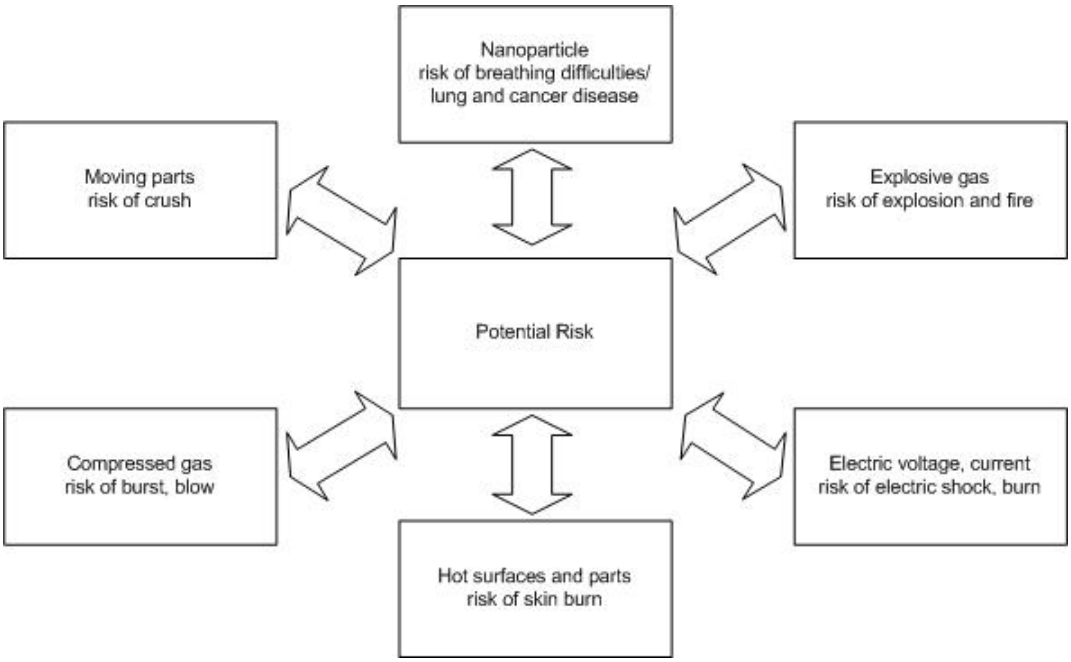


Fig. 3.1: Risk types

3.2. Labels and Explanations

When operating testo REXS, you are always operating under certain risk factors as electricity, explosive and compressed gases, hot surfaces, moving parts and nanoparticles. Therefore testo REXS includes several safety features. Nevertheless, some precautions still need to be taken to ensure safe and reliable operation. Listed labels, Cautions, and Warnings are explained in general, and the further specific labels refer to type of hazard and danger.

Note

Note

Note means this content describes important, useful and/or necessary information to help guide you through the manual.

Caution and Warning

Caution

Caution means be careful. If you do not follow the manual instruction you might cause an instrument or accessories damage, but no human injury. Also Caution refers to important information about installation, operation and maintenance.

Warning

Warning means that improper operation could cause a serious human or instrument damage or injury with consequence of irrevocable instrument damage.

Warnings for testo REXS

Crush

Crush hazard. Keep hands clear of moving parts. Lockout/tagout before servicing.

Electric Shock

Hazardous voltage. Contact may cause electric shock or burn.

Turn off and lock out system power before servicing.

Protection earth

The electroconductive terminal is connected to protection earth.

Skin Burn

Hot surface. Do not touch. To avoid possible skin burns, wear heat protection gloves or turn heating off and allow surfaces to cool down before servicing.

Explosion

Explosion hazard. Inflammable gas. A gas leak may cause an explosion or burn. Before turning on the instrument check gas leak tightness.

Gas filled cylinders

Compressed and explosive gas. Broken or leak cylinder may destroy the locality and environment.

Soot Nanoparticles

Soot particles hazard. When breathed in, soot particles may cause adverse carcinogenic health effects to organism. The human immune system is not able to completely deflate inhaled nanoparticles; they may enter and remain in the human body.

Toxic gas

Toxic gas hazard. The emission consists of toxic gas CO and CO2, that may result in adverse health effects.

Safety dispositions

Gas cylinder support

Risk of tilting gas cylinder. Secure the standing gas cylinder with a chain or belt.

Eye protection

Eye hazard. Explosive gas surrounding, particles and bright flame may affect the eyesight.

Ear protection

Ear protection. To fade out monotone sound location.

4 System Overview

Fig. 4.1: testo REXS instrument

4.1. Soot Generation Principle of testo REXS

4.1.1. Principle

The soot aerosol generator is simulating the exhaust from a diesel combustion engine. The gas fuel burner generates soot of selectable particle size and number concentration. The function principle is based on a propane fuel diffusion flame that is quenched by air. From this follows that propane (C_3H_8), nitrogen (N_2) and air are transformed into carbon monoxide (CO), carbon dioxide (CO_2), water vapour, and soot nanoparticles.

4.1.2. Applications

Compared to a diesel combustion engine, testo REXS generates reproducible, constant and stable exhaust gas flow and especially soot nanoparticles. This is a gain for the filter industries regarding measurement of any particle filters of combustion engines as vehicles, ships, locomotives, or cranes and calibration of engine test benches. Testo REXS may also be used to test and certify air intake filters, cabin filters or dust absorbers.

4.1.3. Functionality

Testo REXS is built up in a mobile 19" rack. The straightforward design and clear layout ease its operation. Indicators, display and software enable control and monitoring of the control parameters.

4.2. The Benefits Are

- Soot aerosol generator, simulating exhaust from a modern diesel combustion engine.
- Real soot nanoparticles, reproducible in size and concentration.
- Aerosol output flow approx. 700 l_N/min.
- Adjustable particle sizes of approx. 60, 80 and 100 nm.
- Soot nanoparticles mass output of 1.5 g/h at 80 nm.
- Capable to work against back pressure up to 500 mbar.
- Flexible and simple operation.
- Simple test bench integration.
- Local and/or remote control.
- Very low maintenance effort needed, low down-time.

4.3. Function Principle

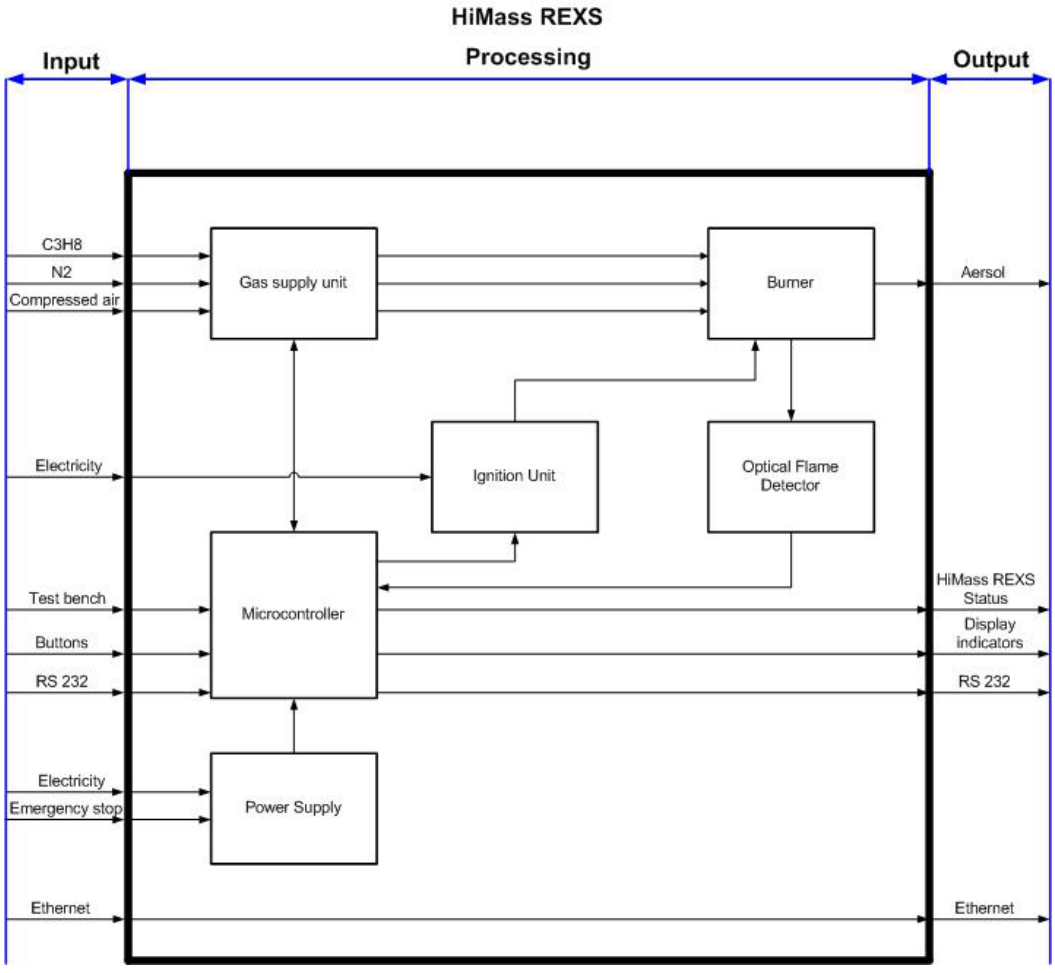


Fig. 4.2: Function principle

4.4. The System

To operate testo REXS, only propane, nitrogen, compressed air, and one phase electricity is required.

Gas and air supply, power supply and test bench devices mounted to the burner outlet have to be provided and installed by test bench manufacturer. The block diagram in Fig. 4.2 shows the testo REXS system design with all electrical and gas lines, by inputs and outputs.

4.4.1. Soot Generator

testo REXS is controlled by a microcontroller. It supervises gas pressures, gas flows, remote control signal, flame status and aerosol temperature, and it drives automatic ignition, display and LED indicators. Furthermore it controls the operating point change, start-up, gas mass flow controller, valves and shut down. With only the two buttons Burner ON/OFF and Operating Point at the front panel testo REXS is controlled. Communication to the remote operation software is done by a protocol over a EIA-232 serial interface.

4.4.2. Input

Gas supply unit, propane and nitrogen

Compressed propane and nitrogen supply with the matching technical requirements are connected to testo REXS by encoded quick couplings. Precision pressure regulators adjust the gas pressures, before the gases are purified through HEPA filters. Pressure switches and safety shut-off valves control the minimal required pressure for safe operation. Mass flow controllers set the nominal gas flows depending on the selected operating point. Propane and nitrogen are mixed downstream of the MFC and lead into the burner.

Compressed air

Oxidation air:

The compressed oxidation air is supplied through an encoded quick coupling. It is purified through a prefilter and a HEPA filter. Oxidation air pressure is controlled by a precision pressure regulator. Pressure switch and safety shut valve controls the minimal required operation pressure. A mass flow controller sets the nominal oxidation air flow depending on the selected operating point. Oxidation air is then lead to the bottom part of the burner.

Note

Oxidation air is feeded internally from quench air in standard setup. A separate oxidation air supply may be used if necessary.

Quench air:

The quench air is supplied through an encoded quick coupling. It is prefiltered and the pressure is controlled by a precision pressure regulator. A HEPA filter purifies the quench air before it flows into the MFC. Quench air is controlled depending on the selected operating point. The quench air is lead to the mid part of the burner.

Operation elements:

Burner ON/OFF starts and stops production procedure.

Operation button switches over into the different aerosol production point.

Emergency stop immediately shuts down the process.

Communication interfaces:

RS232 is the communication interface between Microcontroller and external Notebook or PC Desktop. Ethernet connects the internal interface from the notebook to the user ethernet.

4.4.3. Processing

Ignition unit

The flame is ignited with a high voltage spark ignition unit. The ignition energy is provided by high voltage transformer with a capacity of 15 kV. During the ignition procedure a carriage moves the spark ignition electrode into the combustion chamber and ignites the injected combustion gas. As soon as the optical flame sensor detects the flame the electrode carriage is refracted to its initial position, as well as after 5 unsuccessful spark ignition sequences.

Optical flame detector

The optical flame sensor detects the flame, observing the combustion chamber from the bottom and reports the flame status to the microcontroller.

Power supply unit

The power supply unit provides 24 VDC power to the several subsystems of testo REXS. Input voltage may be in a range of 90 to 250 VAC (wide-range input). Fuses values may change depending on the actual supply voltage.

4.4.4. Output

Display signal

It monitors current status of all controlled parameters.

Burner

The mass flow controlled mixture of propane and nitrogen is fed into the center of the combustion chamber. The oxidation air is surrounding the fuel gas. The fuel gas and the oxidation air are not mixed; a combustible mixture is only formed at the contact surface of the two gases. The flame size changes with fuel, gas flow and mixture ratio.

A high volume quenches the upper part of the flame. The hot aerosol (gas with particles), which consists of air, carbon dioxide (CO_2), carbon monoxide (CO), water vapour and soot particles, leaves the combustion chamber at the top of the burner.

The soot nanoparticle forming process; Laminar diffusion flame

Since the flame only burns at its outer surface, the gas inside the flame is heated up until the propane is cracked into hydrogen (H_2) and carbon (C). The carbon core particles ascend inside the flame and grow. At the point where the quench air hits the flame, the flame is extinguished and the soot nanoparticles are conserved in the actual size and number particles remain inside. The longer the flame, the more the particles grow in size due to coagulation effects (soot particles collide and stick together).

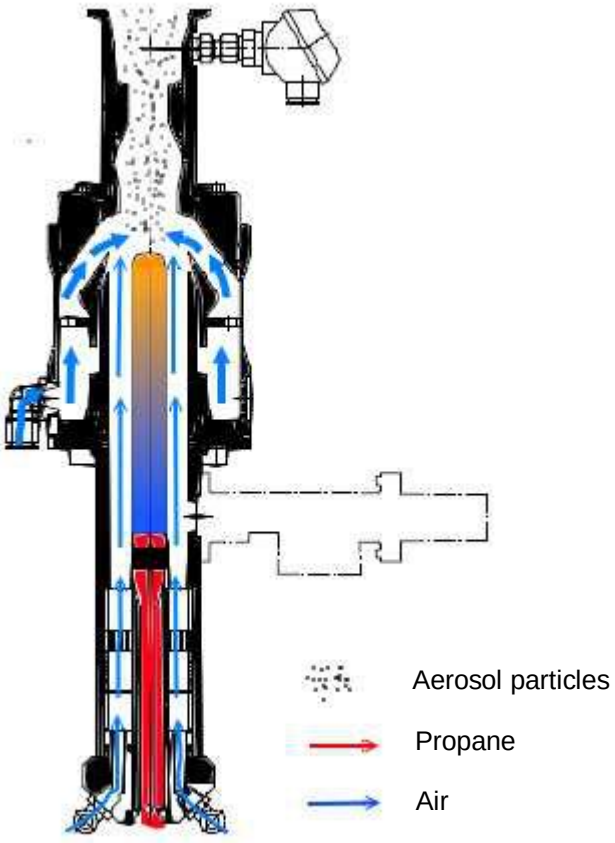
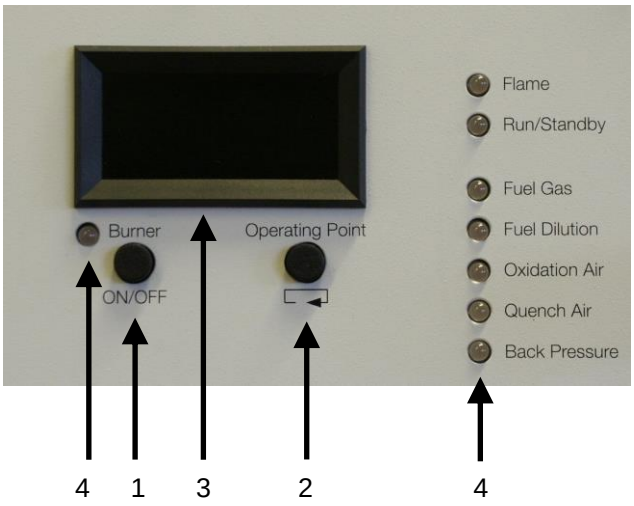


Fig. 4.3: Soot nanoparticle processing

4.5. Front Panel Operational Elements

The operating front panel at the left side includes two buttons, a display and seven LED indicators.



Pos #	Description	Function
1	Burner ON/OFF	Start/Stop / confirm messages / clear errors
2	Operating point	Chosse operating point / cancel/quit
3	Four dot matrix display	Status / error codes / messages
4	LED indicator	Refer to table below for a detailed function description

Fig. 4.4: Front panel

LED signal lamps

Active green indicators refer to a positive status and therefore to a reliable operation. Red indicators refer to an error.

Description	green	red	dark
Flame	Flame on	Flame not detected	Burner off
Run/ Standby	Run mode	Standby mode	Burner off
Fuel Gas [1)]	Propane ready, flow	Propane not ready, out of tolerance	Burner off
Fuel Dilution [1)]	Nitrogen ready, flow	Nitrogen not ready, out of tolerance	Burner off
Oxidation Air [1)]	Oxidation ready, flow	Oxidation not ready, out of tolerance	Burner off
Quench Air [1)]	Quench air ready, flow	Quench air not ready, out of tolerance	Burner off
Back pressure	Back pressure below 500 mbar	Back pressure above 500 mbar	Burner off

Note

The range of tolerance is

- 1) within ±3 % of the end range value
- 1) over ± 3% and between ±6 % of the end range value

The operating front panel at the right side includes a propane concentration warning indicator and an emergency stop button.

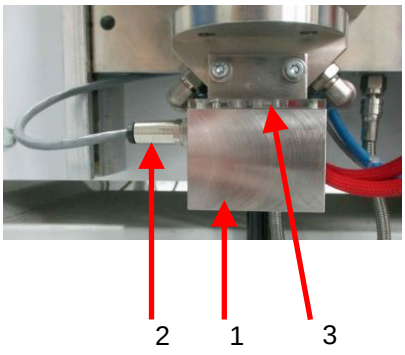
Pos #	Description
1	Fuel Gas Alarm In combination with an audio warning the fuel gas alarm indicator lights up when a high propane concentration is detected. Clear by pushing the button when the problem is resolved.
2	Emergency Stop Interrupt power supply and immediately stop testo REXS operation. Put back by pushing and also turning right side the button when the problem is resolved.

Fig. 4.5: Warning indicators

Warning
Explosive gas. Propane sensitive safety devices. In case of any malfunction shut down all other electrical devices in the same room. Room and device must be evacuated!

Flame detector

Active green indicators refer to a positive status and therefore to a reliable operation. Red indicators refer to an error.

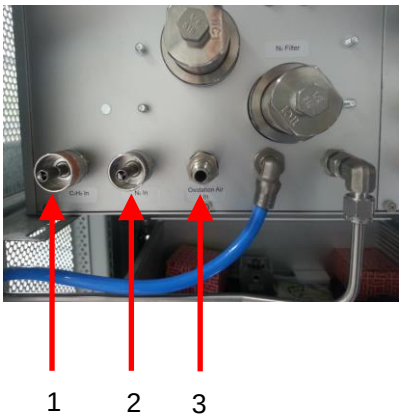


Pos #	Description	Connector
1	Flame detector unit	56 x 56 x 46mm customized flame detector
2	Communication port	4 pin 14 mm socket
3	LED indicator, Flame status	Green: ON Red: OFF

Fig. 4.6: Flame detector

4.6. Back Panel Operational Elements

Gas supply connectors

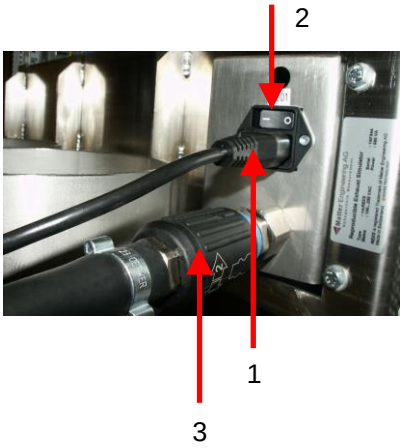


Pos #	Description	Connector
1	Propane C_3H_8	Swagelok quick coupling, code orange
2	Nitrogen N_2	Swagelok quick coupling, code black
3	Oxidation air	Legris quick coupling, ISO B6 [1)]

1) Note: oxidation air is supplied internally in standard setup

Fig. 4.7: Gas supply connector

Electrical power and compressed air connectors



Pos #	Description	Connector
1	Mains power plug	IEC 60320-C14, plug type
2	Main switch	0: off 1: on
3	Compressed air	Legris quick coupling, ISO B8

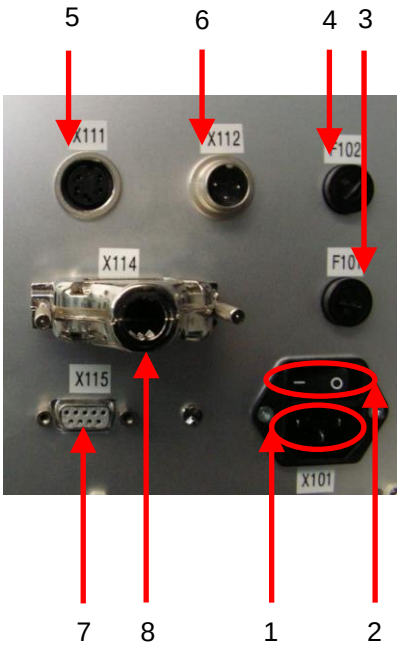
Fig. 4.8: Electrical and air connectors

Internal fuses

Pos #	Description	Connector
1	F201, Fuse Spark Ignition	Weidmüller
2	F202, Fuse Notebook drawer	Weidmüller

Fig. 4.9: Internal fuses

4.7. Back Panel Connectors



Pos #	Function	Connector
1	Electrical power supply for control insert. Power is supplied from main power in standard setup.	Type IEC 60320-C14 plug
2	Control insert supply switch	0: control insert off 1: control insert on
3	Control insert fuse	Main voltage fuse, 5x20mm [1)]
4	Spare insert fuse	Main voltage fuse, 5x20mm [1)]
5	Closing contact on 1-2, sets testo REXS from standby mode to run mode [2)] Feeback: 3-4 closed: stby 3-5 closed: run	5 pin 18 mm socket
6	Opening contact on 1-3, interrupts power supply [3)]	3 pin 18 mm socket
7	EIA-232 serial communication with PC	9 pin Sub D socket
8	Internal diagnostic, for factory only use	25 pin Sub D socket

1) note: refer to the label next to the fuse carrier for replacement fuse type and capacity.
2) note: a plug with 1-2 bridge is supplied with testo REXS
3) note: a plug with 1-3 bridge is supplied with testo REXS

Fig. 4.10: Back panel connectors

5 Transportation, Unpacking and Extend of Delivery

5.1. Transportation

Caution:
The wooden transportation box is particularly designed for safe transportation of testo REXS. Store the transportation box in a dry place when not used. Use only the original packaging for transportation or shipping of testo REXS. The instrument may suffer serious damage if it is not shipped in the original transportation box.

Note:
testo REXS is shipped in a reusable, wooden transportation box. This box can be transported either in upright or in lying position. Use a pallet lifting truck or a pallet jack.

Warning:
When moving the box in an upright position, take precautions to ensure that it does not tip.

Note:
ISPM15 Packing Regulation.
The wooden packaging is subject to the ISPM15 regulation, that defines how to cover chemically wooden packagings for international transportation. The ISPM15 label and the packaging manufacturer identification code is printed at the front cover of the package.

5.2. Unpacking

Once the box is in the right place, put it in upright position. Loosen the 6 clamps and remove the front cover. Take out the wooden ramp that is stored in the ceiling of the box and attach it to the countersinks at the box floor. Make sure that the ramp is held in the positioning holes. Remove the fastening belts and the frontside clamp board. Roll testo REXS out of the box carefully.

Note:
Follow the instruction sheet „how to unpack testo REXS“ attached to the transportation box.

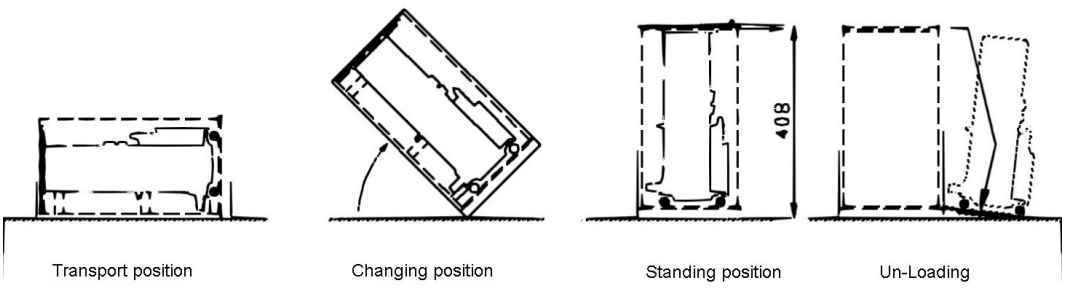


Fig. 5.1: Unpacking testo REXS

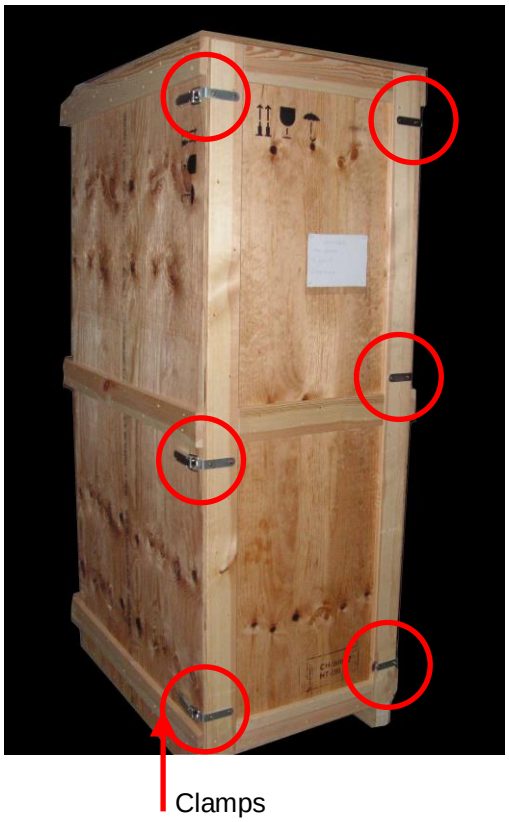


Fig. 5.2: Clamps on the packaging

Fig. 5.3: Instrument in the transportation box

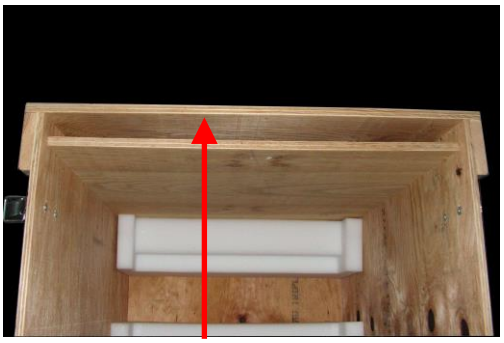


Fig. 5.4: Ramp storage

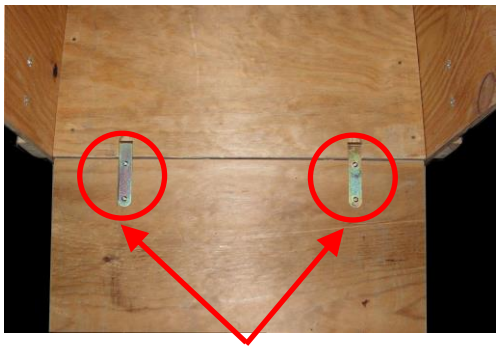


Fig. 5.5: Ramp positioning

5.3. Storage, Acclimatisarion

Fast ambient temperature changes may result in condensed water on and inside of the instrument. This may cause serious damage of electronic parts, e.g. the controller or safety devices.

- Do not store the instrument outdoor, the storage environment must be dust free and dry.
- Always store testo REXS in the specific wooden packing.
- After long time storage or transport with cold ambient condition or thermal fluctuation, the instrument requires to adapt slowly the local ambient condition before starting up.
- If condensed water has been formed, wait at least 12 hours before installation and starting up.
- Avoid mechanical damage and agitation.
- Storage temperature range: -10°C to + 60°C.

5.4. Extent of Delivery

testo REXS delivery consists of the following items:

Item #	Quantity	Part number	Description
1	1 ea.	366	Testo REXS
2	1 ea.	V1215	wooden transportation container, reusable
3	1 ea.	power cord with specific plug, see next line	78021 for country CH 78022 for countries D, FR, IT, Corea 78023 for countries USA, CA, JP 78024 for country GB
4	1 ea.	1208	- Compressed air hose, 5 m length - Quick couplings Legris ISO B8 safety
5	1 ea.	None	Compressed C3H8 hose with excess flow device and encoded Swagelok quick coupling (orange), 1 m length
6	1 ea.	None	compressed N2 hose with excess flow device and encoded Swagelok quick coupling (black), 1 m length
7	1 ea.	R2635	5 pin 18 mm plug X111: testo REXS remote control
8	1 ea.	R2633	3 pin 18 mm socket X112: external emergency stop
9	1 ea.	56113 5 AT	spare fuse for F101, control unit
10	1 ea.	56113 5 AT	spare fuse for F102, 9.5“ insert
11	1 ea.	6,3 AT	spare fuse for F201: ignition
12	1 ea.	56113 5 AT	spare fuse for F202: notebook drawer power socket
13	1 ea.	R3501	Mixer SMV, DN50 ISO-KF
14	1 ea.	R3606	45° or 90° elbow, DN50 ISO-KF
15	1 ea.	R3605	Tee, DN50/DN16 ISO-KF
16	1 ea.	R3607	blind flange, DN16 ISO-KF, with Swagelok 8 mm tube fitting
17	1 ea.	R3604	bulkhead clamp, DN16 ISO-KF
18	3 ea.	R3603	bulkhead clamp, DN50 ISO-KF
19	1 ea.	R3602	centering ring, DN16 ISO-KF
20	3 ea.	R3601	centering ring, DN50 ISO-KF
21	1 ea.	none	Testo REXS remote operation software CD
22	1 ea.	none	User Manual
23	1 ea.	none	CD with graphical User Interface (GUI)

Note:
Items 3 to 22 are packed in a cardboard box. This box is attached to testo REXS.

Fig. 5.6: testo REXS

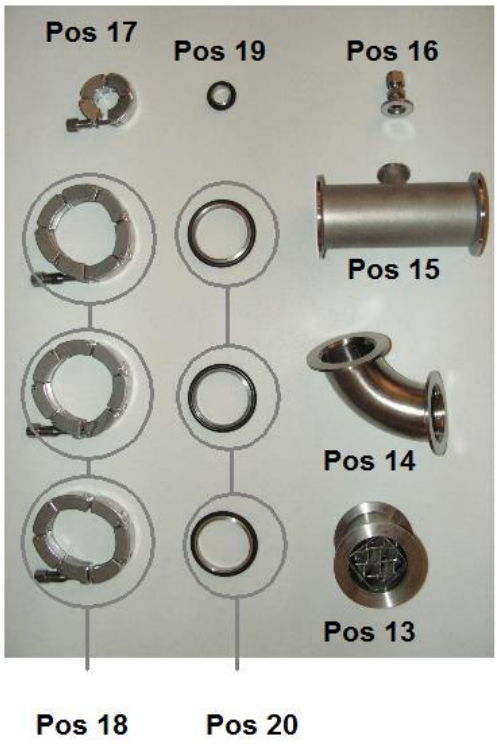


Fig. 5.7: Flanges, centering rings and bulkhead rings

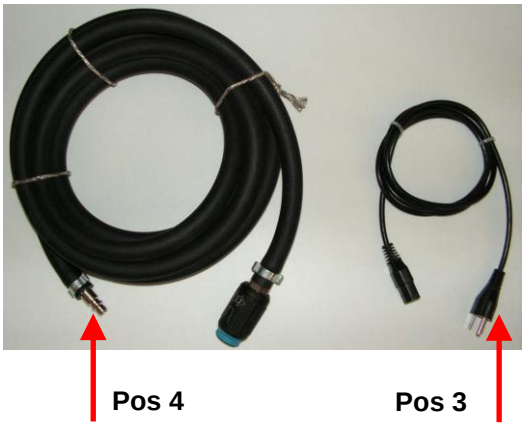


Fig. 5.8: Air hose and power cable

Fig. 5.9: Flange built up

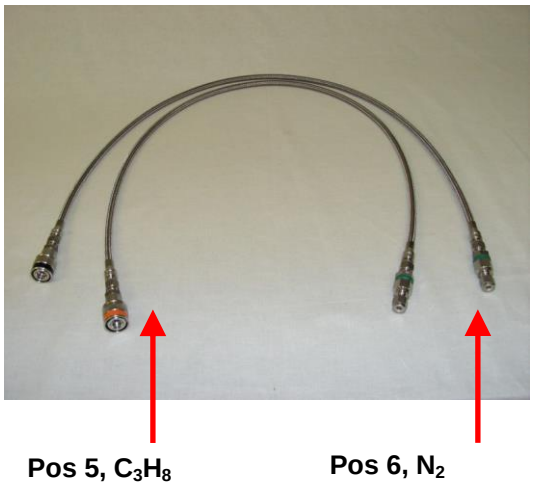


Fig. 5.10: Gas hoses

Fig. 5.9 shows an example how to assemble the mixer; the 90° elbow and tee. This setup provides homogenised aerosol, horizontal outlet and 8 mm sampling port.

6 Setting up and installation

6.1. Operation Environment Requirements

Caution:
Read this section carefully before setting up testo REXS. Testo SE & Co. KGaA is not liable if the instrument is damaged, caused by the operation environment not meeting the requirement.

Caution:
The testo REXS Aerosol generator is designed to be installed in a laboratory, test stand or a temporary test set-up. The instrument is not intended to be used outdoor or in a dusty or wet environment.

Incline	The floor where testo REXS is set up has to be levelled, the maximum incline is <3 %. The front castors must always be blocked to prevent inadvertent rolling.
Elevation	testo REXS can be run up to 2000 meter above sea level.
Floor load capacity	Floor load capacity has to be 400 kg/m2 in minimum
Ambient air conditioning	Provide enough cool ambient air for convection cooling of the burner and tubing. Do not operate testo REXS in small rooms without ventilation or in a setup with insufficient ambient air circulation
IP protection degree	IP 20. testo REXS is protected against accidental contact to dangerous parts of the instrument. It is not protected against intrusion of sand, dust or water. Avoid water operation in dusty or wet environment for safe and reliable operation.
Safety clearance	testo REXS must be set up apart from any other object, walls and ceiling. The minimum safety clearance is one (1) meter on each side.

Operating temperature range	The operating ambient temperature range is between +10 °C and +40 °C
Humidity range	The ambient relative humidity range (RH) is 10% to 80% (80% at 31 °C, linear degrading to 50% at 40 °C), non condensing
Shocks and vibration	Avoid operation under any kind of shock or vibration
Explosive gas	Equipped with built-in propane sensitive savety device. In case of propane concentration of >0.1% operation will be stopped by emergency error

6.2. Installation

Follow the instructions provided in this section before starting up the testo REXS.

Preparation

- Unpack testo REXS from the wooden case. Refer to chapter 5.2, Unpacking, for more detailed instructions. Store the wooden case in a clean and dry place for later transportation of the instrument.
- Lock the caster rollers from testo REXS on its location.
- Check quantity and quality of the accessories delivered with the testo REXS according to the chapter 5.4 Extent of delivery.
- Set up testo REXS in the designated position in sufficiently low distance to the compressed gas cylinder or the gas supply connectors.

Note:
C_3H_8 is highly combustible and toxic.

Warning:
Place the C_3H_8 fuel gas cylinder in a position with easy access to the main valve. Always close the main valve first in case of fuel gas alarm or smell of fuel gas!

Gas supply connections

- All gases are supplied by supply net or gas cylinder.
- Ensure that the compressed gas pressure and gas quality meet the requirements. Refer to gas supply specification in chapter 7.1, Specifications and technical data.
- Always use appropriate gas line shutoff valves, pressure regulators and fittings.
- Ensure that all valves are closed at the compressed gas cylinders or at gas supply lines.
- Ensure that the mechanical dimensions (length, diameter) of the outlet port meet the requirements. Refer to the gas interfaces in chapter 7.1, Specifications and technical data.
- Connect the delivered metal shielded gas hoses for C_3H_8 (orange quick coupling) and N_2 (black quick coupling) to the correct outlet port of the gas cylinder reducing valve or the gas supply line pressure regulator. Fasten the Swagelok tube fitting 1 1/4 turns from finger-tight position. Use an appropriate wrench. Connect the encoded quick couplings to the sockets at testo REXS's back panel, refer to chapter 4.6, Gas supply connectors.
- Open the main valve and adjust gas pressures for C_3H_8 and N_2 to 4 to 5 bar. See chapter 7.1, Specifications and technical data, to meet the requirements.
- Make sure the room is ventilated proper.
- Make sure a fire extinguisher is accessible in the operating room.

Compressed air supply connection

- Ensure that the compressed air pressure and air quality meet the requirements. Refer to 7.1, Specifications and technical data, for detailed information.
- Always use appropriate gas line shutoff valves, pressure regulators and fittings.
- Ensure that the mechanical dimensions (length, diameter) of the outlet port meet the requirements. Refer to chapter 7.1, Specifications and technical data.
- Ensure that the compressed air supply port is equipped with a coupling that meets the requirements. Refer to specification, chapter 7.1, Specifications and technical data.
- Adjust the compressed air supply pressure to 7 bar.
- Connect the compressed air hose to the compressed air supply port. Connect the Legris safety quick coupling to the compressed air. The inlet is located at the bottom backside, next to the electrical main port. Refer to chapter 4.6, Back panel operational elements.
- If desired, the user may connect a separate hose with Legris ISO B6 safety coupling. In standard setup, oxidation air is supplied internally from the main compressed air line directly to the oxidation inlet at the upper back panel. Refer to chapter 4.6, Back panel operational elements.

Electrical connection

- The one phase power cord delivered with the instrument is equipped with a country-specific plug and protective earth.
- testo REXS is designed to run either with 230 VAC or 110 VAC power supply. Refer to the label to determine supply voltage for the instrument.
- Connect the IEC 60320-C13 socket of the power cord to the IEC 60320-C14 plug at the back side of the instrument next to the compressed air inlet.
- Connect the power cord plug to a grounded power socket.

Caution:
Keep access to main switch free!

Adjust the aerosol outlet position

- The burner is mounted on a movable slide. It can be lowered and raised to adapt the vertical aerosol position to the test bench required level. To adjust the aerosol outlet position, open the four hexagonal socket screws with a 6 mm hexagonal socket wrench and place the burner in the desired position. Block the slide by fastening the 4 screws.

Additional accessories for the burner outlet

- Parts 13 to 20 are optional parts to be connected to the burner outlet, if used. The mixer provides improved aerosol homogeneity, the 45° or 90° elbow enables to swivel the aerosol outlet. The T-fitting with 8 mm tube fitting provides a sampling port close to the burner outlet.

Note:
When using the sampling port tee, consider aerosol temperature and pressure as well as possible particle concentration inhomogeneity at the sampling point.

Warning:
Flow oscillations or pressure fluctuations at the burner outlet may lead to pressure peaks. These pressure peaks may cause emergency shutdown of testo REXS and/or damage of the DUT and the test bench tubing and attached devices.

Warning:
The aerosol leaving the testo REXS burner may heat up to 300 °C. The tubing, fittings and DUT have to be designed to withstand the aerosol temperatures that may occur.

Warning:
System may work at pressures up to 500 mbar. Tubing and concerned parts have to be tested up to withstand a pressure of 1.0 bar. Make sure that the test bench tubing and DUT are leak free up to 1.0 bar.

Emergency Stop

- The external emergency stop plug X112 is bridged when delivered and ready for stand alone operation. When using an additional external emergency stop contact, e.g. a global test stand stop, open plug X112 and remove the bridge between pin **1 and 3**. Solder the wires leading to the external emergency stop contact to pin **1 and 3** of the plug X112. Re-assemble the plug.

Note:
Pin 1 and 3 are bridged on delivery. This enables stand-alone operation of the testo REXS.
Refer to chapter 4.7, Back panel connector, for contact specifications.

Warning:
The external emergency stop must provide an isolated, floating opening contact (normally closed, NC) and comply with the specific regulations. Safe operation is not guaranteed if an unsuitable external emergency stop is used.

Caution:
Use a shielded cable of max. 30 m length. Connect the shielding to the connector housing. Conductor cross-section has to be 0.25 to 0.5 mm^2.

Test bench run / standby control

- testoREXS may to be controlled with an external run/standby signal, e.g. provided by the test bench control unit.testo REXS provides a state signal indicating whether soot nanoparticles are being emitted or not. To access these signals, open plug X111. Remove the bridge between pin 1 and 2. The test bench control signal („RUN“ = closing contact) has to be connected to pin 1 and 2. The testo REXS state signal may be accessed at pin 3 and 4 („RUNNING“ = opening contact), or pin 3 and 5 („RUNNING“ = closing contact).

Note:
Pin 1 and 2 at plug X111 are bridged on delivery. This enables stand alone operation of testo REXS.
Refer to chapter 4.7, Back panel connector, for contact specifications.

Note:
When the external test bench control contact is open, testo REXS switches to standby mode. When the external test bench control contact is closed, testo REXS switches to the last operation point selected.

Caution:
Use a shielded cable of max. 30 m length. Connect the shielding to the connector housing. Conductor cross-section has to be 0.25 to 0.5 mm^2.

Computer or notebook connection

- testo REXS provides a drawer with a power socket, an EIA-232 serial connection to the testo REXS control unit and a RJ45 Ethernet connection to the backside of testo REXS.
- To use a notebook in the notebook drawer to control testo REXS, connect the shielded serial cable, length <30 m, to a free serial port of your computer. To use a desktop PC to control testo REXS, disconnect the serial cable from the 9 pin sub-D connector X115 on the testo REXS control insert back panel and connect the external serial 9 pol cable to connector X115 on the back panel.
- To set up a connection from the notebook in the notebook drawer to a computer network, connect the built in RJ45 plug to the network interface connector of the notebook and

connect the RJ45 socket on the backside of testo REXS to a free socket of the computer network. Use a RJ45 Ethernet patch cable.

- To supply the notebook with power, connect the plug of the notebook power supply unit to the power socket located on the back panel of the notebook drawer.

PC software installation

Refer to the software manual in the Appendix.

Note:
The computer must meet the minimum requirements specified in Appendix chapter 7.1, Specifications and technical data.

Warning:
The power socket provides mains voltage at a rated power of 120 VA. The power socket is protected by a blow fuse F202. Ensure that the rated input voltage and power consumption of the attached device meet the requirements.

Caution:
Dangerous voltage. The power socket provides mains voltage. Voltage may be up to 240 VAC, depending on testo REXS supply voltage. Do not open or damage the power socket or power cables attached. Never connect open, uninsulated, ungrounded or defective devices to the notebook drawer power socket.

Only use the notebook drawer power socket to supply the notebook computer.

Only use the power supply unit delivered with the notebo.

6.3. Test Stand Preparation

- Connect the aerosol outlet to appropriate tubing that leads the aerosol to the dilution tunnel or the device under test (DUT). Use the bulkhead clamps and centering rings delivered with testo REXS.
- Keep the tubing as short as possible to prevent particle losses caused by diffusion and coagulation.

Caution:
Do not restrict the aerosol flow out of the burner. The aerosol flow is mass flow controlled. Restricting the aerosol flow, e.g. by closing a valve will result in immediate back pressure raise. Always lead the aerosol through a bypass before shutting off a tubing line.

6.4. Operating Instructions

Putting testo REXS into operation

- When testo REXS is connected to all gases, electric power and the test stand, it is ready to run. Open the gas supplies and verify that the gas pressures are within the specified range. Make sure that the internal and external emergency stops are released. Ensure the test stand control does not provide a „RUN“ signal.
- Then switch on the power switches located near the main power socket of testo REXS and on the rear panel of the testo REXS control insert. The display on the frontside shows alternately „INIT“ and „REXS“, then „Welcome to testo REXS“, and finally „IDLE“.
- testo REXS is now ready to be started. Press the left button below the display (Burner ON/OFF). You are asked „RUN?“. Confirm by pressing the left button again, abort by pressing the right button.
- When you have confirmed, testo REXS runs the automatic start sequence. „WAIT“ is displayed. As soon as the flame is ignited, the display shows „STBY“.
- When the flame is not ignited after 5 ignition trials, testo REXS flushes the burner and returns to „IDLE“ state.
- To stop testo REXS when it is running, press the left button (Burner ON/OFF). „STOPPING“ is displayed, followed by „RINSEING“ and finally „IDLE“.

- To switch testo REXS to run state, set the „RUN“ signal from the test stand control. testo REXS changes to the last operating point selected. To return to standby mode, clear the „RUN“ signal. To change the operating point, press the right button when testo REXS is in „RUN“ state.
- Press the right button several times until the display shows the required operating point.

6.5. Note

Note:
It has been examined that pressure shifts in the burner output because slight shifts in the size and number concentration of the particles generated in the burner. Pressure shifts may be caused by meteorological atmospheric pressure variations or operation at a different sea level. Filters as a DUT being loaded may also lead to increasing burner level.

6.6. Warning

Eye protection:
Always wear protection goggles to protect your eyes in case of severe malfunctions.

Warning:
Back pressure upstream of the DUT may rise up to 500 mbar. The tubing, possible dilution air supply and measuring equipment has to be designed to withstand the over pressure that may occur.

Warning:
Toxic gas hazard. testo REXS burner emits toxic gas, CO and CO_2. The test bench has to be installed with HEPA backup filter devices.

Soot Nanoparticles :
Soot particles hazard. testo REXS burner emits soot nanoparticles. The test bench has to be installed with HEPA backup filter devices.

Warning:
Hot surfaces up to 160 °C. Wear heat protective gloves for any manipulation close to testo REXS and for any handling with the DUT after a test.

Warning:
Moving parts. Do not touch ignition electrode or feed cylinder during ignition sequence.

6.7. Test Bench Setup Examples

The following section displays four examples how a test bench, using testo REXS as a soot nanoparticle source may be set up. Note the recommended lengths of the tubing.

Layout 1: Direct connection to DUT.

Application and specification

- appropriate backpressure upstream of the DUT to 100 mbar. In this layout a higher back pressure may result in pulsation and/or aerosol flow oscillation. The soot size distribution and concentration may shift
- appropriate setup when operating with constant flow rate without any additional dilution
- besides the exhaust backup filter, no test bench infrastructure is required

Recommended length

A: 40 cm up to 100 cm lenght

C: When using an exhaust backup filter with tunnel, keep the tube short or use a vertical exhaust pipe to the ambient.

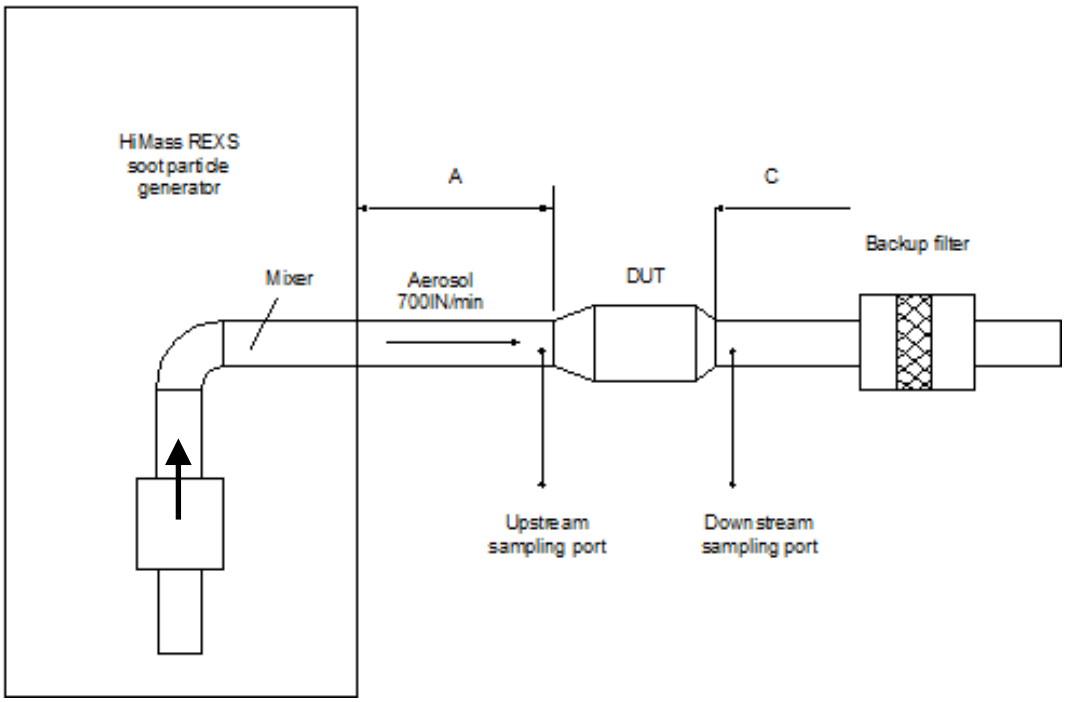


Fig. 6.1: Direct connection of the testo REXS to the DUT

Layout 2: Connection of a DUT with dilution air supply or simple resonance pipe

Application and specification

- appropriate backpressure upstream of the DUT to **200 mbar**. In this layout a higher back pressure may result in pulsation and/or aerosol flow oscillation. The soot size distribution and concentration may shift
- Tee and an additional pipe (B) disposed and, if required, a supply for the dilution air
- adapted for applications with constant flow rate of the REXS or under applications of necessary dilution air

Recommended length

A: Up to 100 cm

B: Approx. 2 or 3 times the length A

C: When using an exhaust filter with tunnel keep the tube short or use a vertical exhaust pipe close to the outlet.

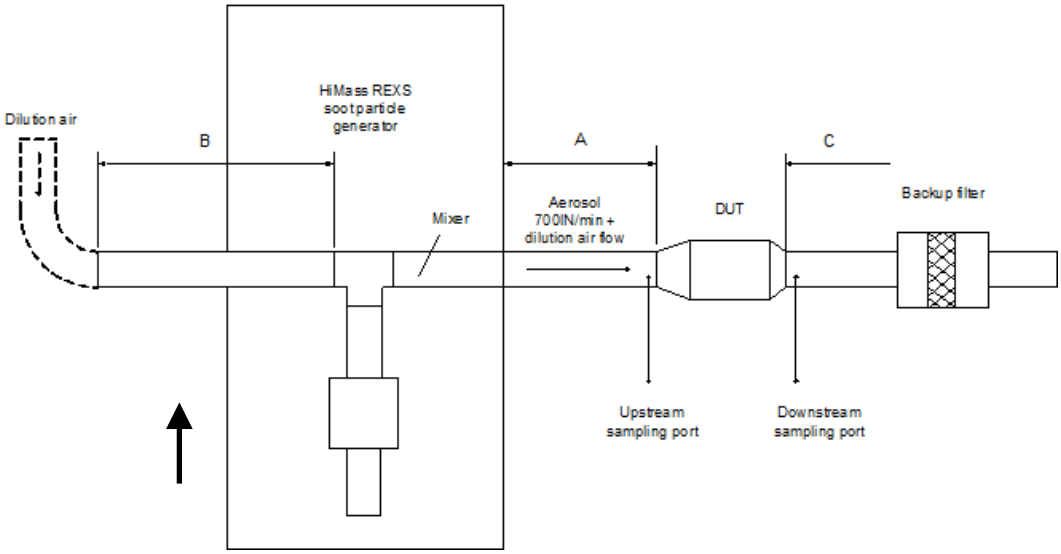


Fig. 6.2: Direct connection of the testo REXS to the DUT with additional dilution air supply

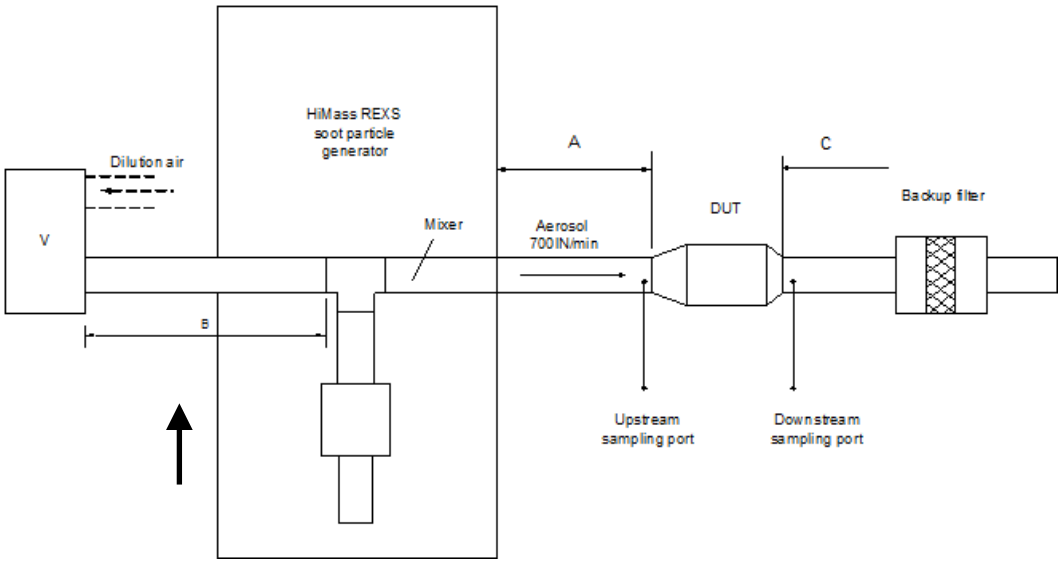


Fig. 6.3: Direct connection of the testo REXS to the DUT with additional dilution air supply with volume (V) to avoid pulsation

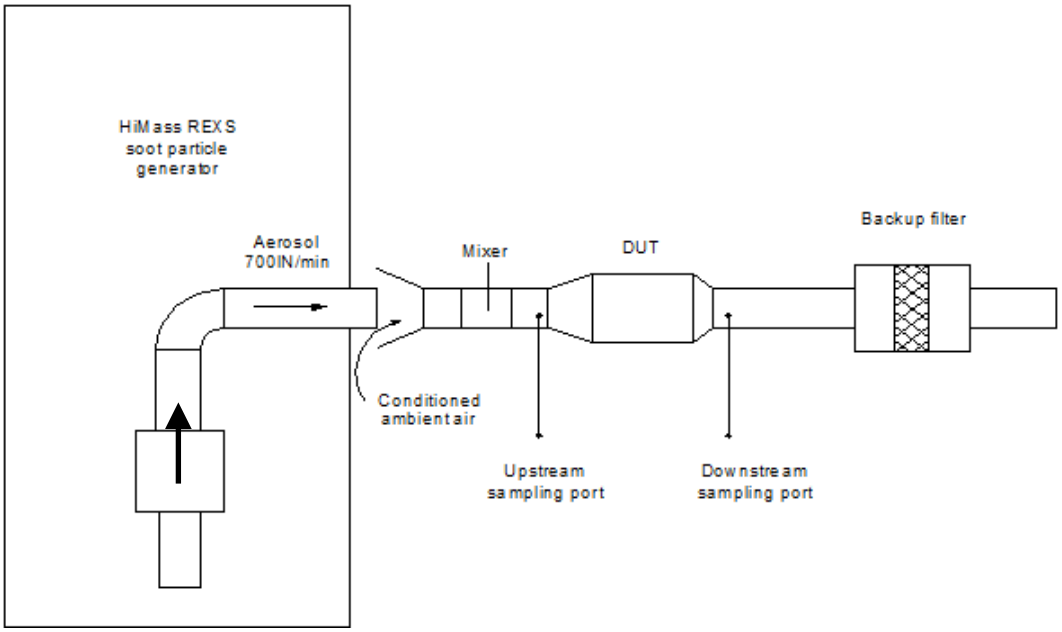


Fig. 6.4: The DUT is not directly connected to the aerosol output. In this measuring configuration the aerosol flow is diluted by conditioned ambient air

7 testo REXS Testing/Programming GUI

Note:
The testo REXS Graphical User Interface (GUI) is delivered on CD or as an electronic installer. The quick guide is also stored on CD.

7.1. System Requirements

The testo REXS GUI runs on computers with Microsoft Windows 2000 or Windows XP professional.

CPU speed: 500 Mhz
Internet Explorer 6
Memory: 256 MB
Disk space: 30 MB

Note:
testo REXS GUI may run on slower computers, but performance is not guaranteed.

7.2. Installation Procedure

Insert the CD ROM into the CD ROM drive of your computer. Open Windows Explorer and browse to the CD ROM drive (e.g. D:). Start the installation by double clicking the „setup.exe“ icon. You also may start the installation by entering Start -> execute -> [CD ROM drive]\setup.exe
The testo REXS GUI installer will lead you through the installation process.

Note:
Please read the licence agreement(s) carefully. If you agree, please confirm and continue the installation. If you do not agree, please abort the installation and return the software and the documentation to your supplier.

The testo REXS GUI is programmed in LabVIEW(TM), version 8.2.1 and runs as an executable using the LabVIEW(TM) runtime engine, version 8.2.1 and LabVIEW(TM) VISA runtime engine, version 4.1. If the runtime engines are not already present, the testo REXS GUI installer will install them as well.

All REXS GUI files will be stored in the program file directory, and a start menu entry is created: *Start -> all programs -> Testo -> REXS GUI -> FMC V2.00*.

When the installer has finished, please read the „readme“ file and start the program. Maybe you will have to reboot your computer to apply all changes to the system.

7.3. Uninstallation Procedure

To uninstall the testo REXS GUI software, browse Start -> system settings -> system control -> software. Mark the item “REXS GUI Vx.xx” and click “change/remove”. Follow the instructions provided by the uninstall assistant.

To remove the LabVIEW(TM) runtime engine, browse Start -> system settings -> system control -> software. Mark the item “National Instruments software” and click “change/remove”. Follow the instructions provided by the uninstall assistant.

7.4. Serial Connection to testo REXS

Plug a one-to-one serial cable with 9-pin D-Sub connectors to the serial port of the computer. You also may use a serial adapter, e.g. for USB. Connect the second plug to the 9-pin D-Sub connector on the rear panel of testo REXS, named “X115”. Secure the plugs by tightening the screws at each connector. Do not over-tighten the screws.

Note:
testo REXS provides a drawer with a built-in serial cable. You may either use the built-in cable or connect a separate cable to the plug on the rear panel.

Open the control panel of your computer and check the available COM ports. Memorise the port number of the COM port where you connected the serial cable to your computer.

7.5. Controls and Indicators

Start the GUI by clicking Start -> all programs -> Testo -> REXS GUI -> REXS GUI Vx.xx. The GUI will open and automatically run.

The testo REXS GUI is designed to look similar to the testo REXS front panel. It provides intuitive operation of the software.

The GUI configuration and connection functions are located at the bottom of the window.

- edit config: enter information about the unit of REXS that is operated with this GUI, e.g. serial number and a detailed description of the specific setup and operating conditions.
- edit port: select the COM port to connect the computer to REXS.
- connect: connect the computer to REXS through the COM port selected in edit port
- lock/unlock REXS: lock and unlock the REXS front panel buttons. Locking the front panel buttons may be useful if you want to prevent local operation of REXS when it is controlled through the GUI. The LED indicator below the REXS display shows locked mode by blinking red and green.
- exit: shut down the testo REXS GUI

The controls and indicators related to the operation of testo REXS are located on a panel, divided into three parts:

- the upper part contains the controls to start and stop testo REXS and to select the operating point. It also contains a large diplay showing the actual operating point
    - display: shows the actual operating point
    - start/stop REXS: start and stop testo REXS
    - select OP: select the desired operating point
    - green indicator: REXS is running at the set operating point
- the center part contains indicators that show internal status data of testo REXS:
    - firmware version: displays the testo REXS microcontroller software version
    - operating hours: displays the hours of operation since the last maintenance and timer reset

- atm. pressure: displays the actual absolute barometric pressure
- gas pres. OK: green indicator displays that C3H8 and N2 gas pressure is OK
- air pres. OK: green indicator displays that oxidation and quench air pressure is OK
- shutoff valves: green indicator is lit when all shutoff valves are open
- C3H8 concentration too high: red indicator is lit if the fuel gas (C3H8) concentration is above normal level

- the lower part provides information about the aerosol output parameters:
  - actual aerosol output: displays the actual aerosol output flow of the burner. The flow is measured in lN/min (slpm), meaning the gas flow at 0 °C and 1013 mbar.
  - back pres. too high: red indicator is lit if the back pressure (pressure inside the burner) is above 500 mbar.
  - back pressure: displays the actual back pressure, measured in mbar
  - run: green indicator shows that soot is being emitted
  - flame: yellow indicator displays that the flame is being detected
  - aerosol temperature: displays the actual aerosol temperature, measured in °C

Note:
The aerosol output temperature is measured at the burner outlet. The aerosol temperature may decrease if the aerosol is lead through the test stand tubing. If you need to know the accurate aerosol temperature at the entrance point of your DUT (e.g. filter), install a separate temperature sensor in a appropriate position.

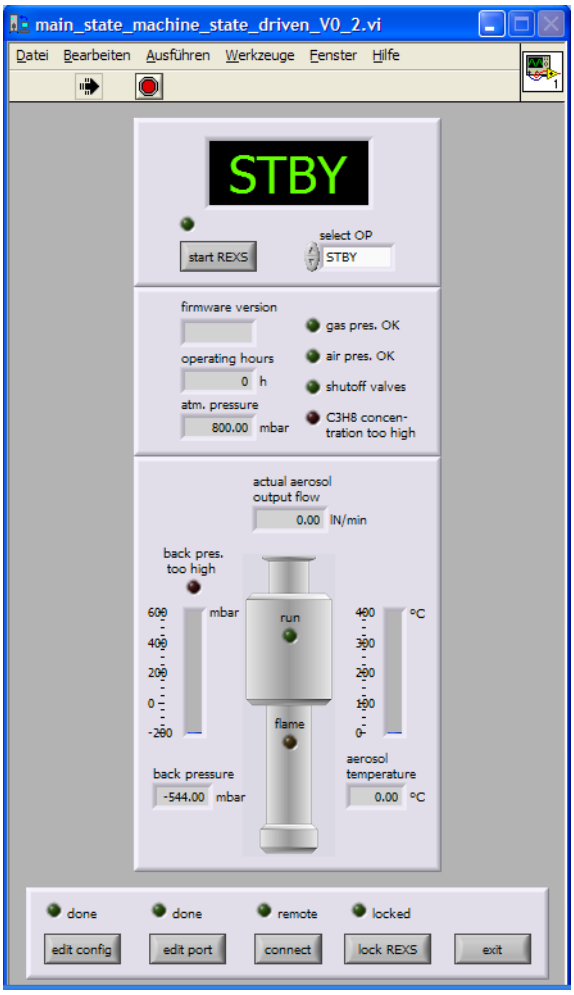


Fig. 7.1: testo REXS GUI window

7.6. Operation of the testo REXS GUI

Connect testo REXS to power and gas supply and perform the start-up procedure, until „IDLE“ is displayed on the testo REXS display.

Start the GUI by clicking *Start -> all programs ->* Testo *-> REXS GUI -> REXS GUI Vx.xx*. The GUI will open and automatically run.

If the test stand setup has changed, click edit config and update the application description. Confirm by clicking OK.

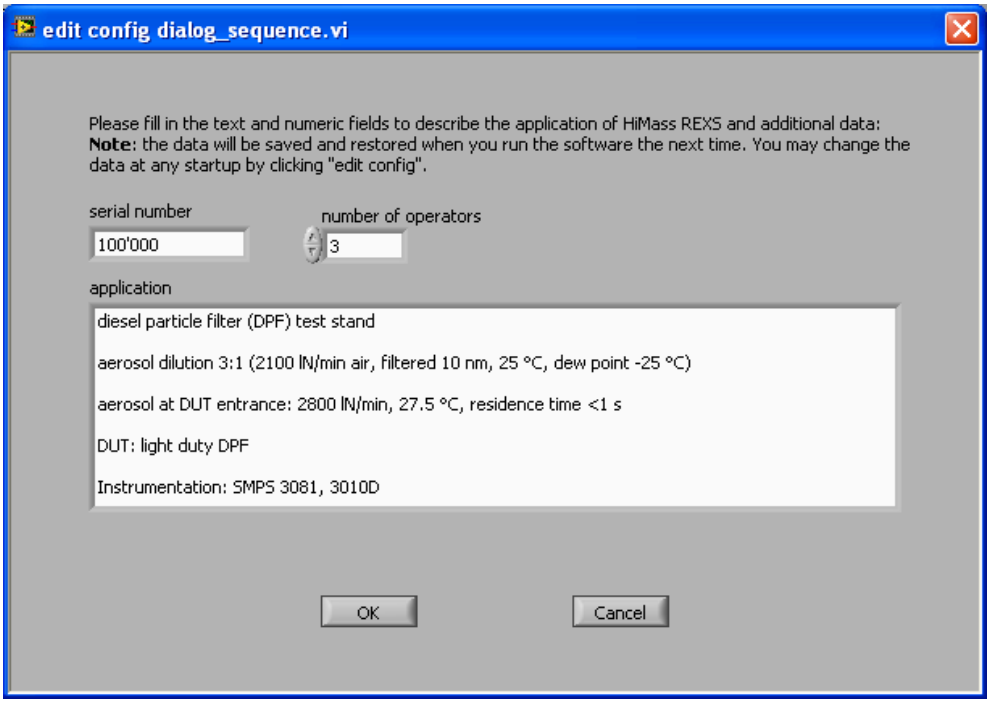


Fig. 7.2: Edit configuration window

Note:
All data entered in edit config and edit port are stored and will be recalled if you run the GUI the next time.

If the COM port has changed, click edit port and select the appropriate COM port from the pull-down menu. All other settings are not modifiable. Confirm by clicking OK.

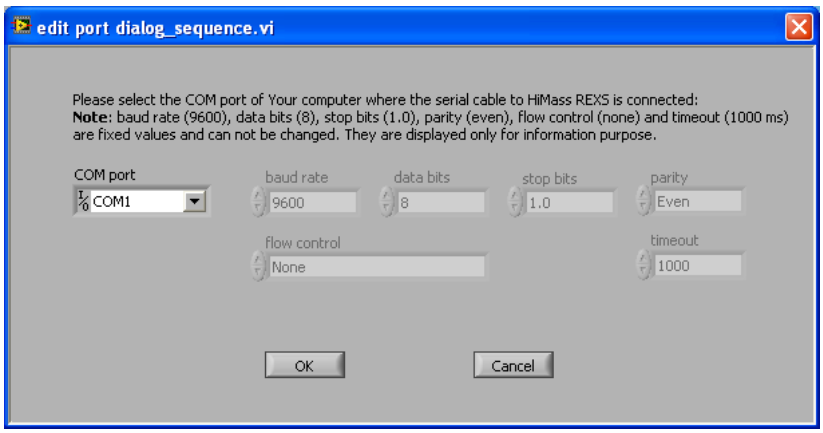


Fig. 7.3: Edit port window

Note:
All data entered in edit config and edit port are stored and will be recalled if you run the GUI the next time.

Click connect to connect the computer to testo REXS.
If desired, lock the testo REXS front panel buttons by clicking lock/unlock REXS.

Note:
Even if testo REXS is in locked mode, all safety devices (emergency stop button, external emergency stop, propane concentration warning) are still fully functional.

Note:
If testo REXS is in locked mode, a dedicated timer watches over the communication. If the communication with the GUI fails, testo REXS switches back to unlocked mode and will shut down with an error.

Click the start/stop REXS button and wait until testo REXS has started properly. After successul start-up, Testo REXS switches to „STBY“ mode, and „STBY“ is displayed on the testo REXS GUI display.
Select the operating point by selecting one of the listed operating points. You also may use the UP/DOWN arrows beside the listbox

Note:
Selecting operating points different to „STBY“ is only enabled when testo REXS is in „RUN“ mode. For more information, refer to the testo REXS manual or quick guide.

To shut down testo REXS, click the start/stop REXS button. Wait until testo REXS has shut down properly.

To exit the testo REXS GUI, click exit. A message window is displayed.

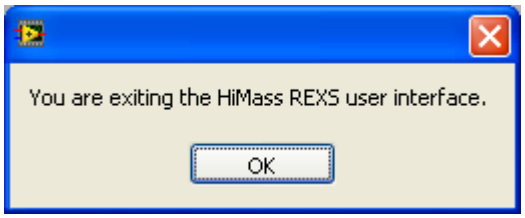


Fig. 7.4: Exit message window

If you are exiting the software while testo REXS is still running, a window will appear and ask you how to proceed:
• unlock testo REXS and exit the software: unlock testo REXS, if it is locked, do not switch to „STBY“ mode or shut down testo REXS, but quit the GUI.
• shutdown testo REXS and exit the software: shutdown testo REXS and quit the GUI.
• set testo REXS to standby mode: switch testo REXS to „STBY“ mode. The GUI will remain open and running.
Click OK to confirm the selection, or click Cancel to go back to the GUI without changing the actual state.

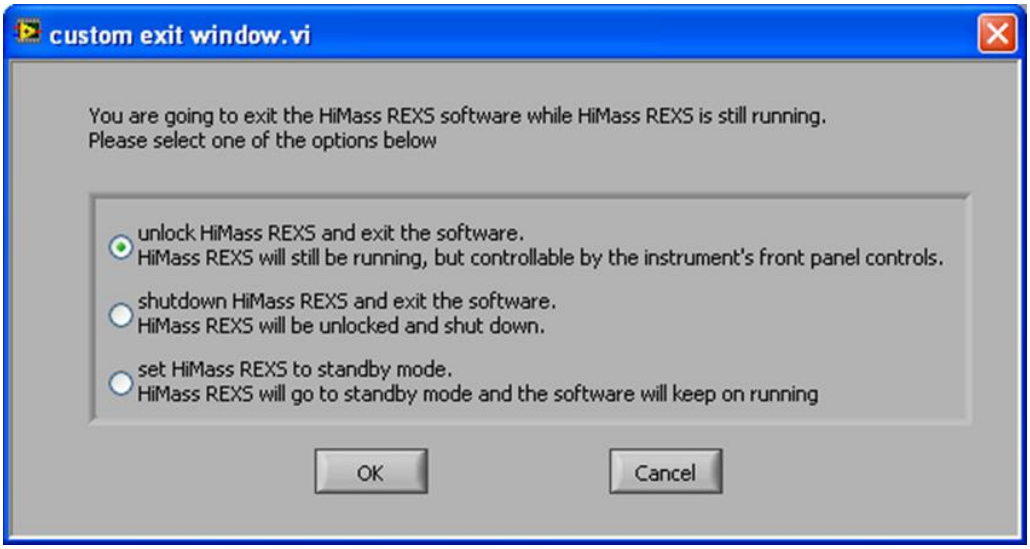


Fig. 7.5: Exit options window

7.7. Errors/Troubleshooting

All communication and hardware errors are reported and displayed. To proceed, you have to confirm every error message displayed.

7.7.1. Communication Errors

A communication error occurs if the testo REXS GUI fails to establish a connection to testo REXS, or if the communication is interrupted. The following error messages are displayed:

- internal program code errors with description
- timeout when writing to or reading from testo REXS through the serial connection
- data loss or no answer from testo REXS.

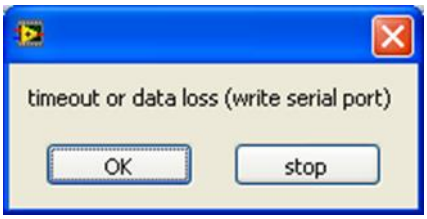


Fig. 7.6: Communication error window (example)

If you click OK, the GUI will retry to communicate with testo REXS. However, if the communication fails several times, click stop to exit the GUI. Locate the error source, fix the error and restart the GUI.

7.7.2. Testo REXS Errors

The testo REXS microcontroller records every error in a error memory stack. The 8 latest errors are stored in the non-volatile memory section. Every error is displayed on the testo REXS front panel display. The Display is switching between a error code and a four character abbreviation of the error.

error code	**display**	**error description**
0	ER00 - NOER	No error occurred
1	ER01- GAPR	Gas (C_3H_8/N_2) and air (oxidation/quench) pressure too low
2	ER02 - GAPR	Gas pressure (C_3H_8/N_2) too low
3	ER03 - GAPR	Air pressure (oxidation/quench) too low

4	ER04 - FLNO	Flame still burning afte flushing of burner
5	ER05 - FLO	Flame not detected
6	ER06 - MFC1	Actual value of C_3H_8 mass flow controller out of tolerance window
7	ER07 - MFC2	Actual value of N_2 mass flow controller out of tolerance window
8	ER08 - MFC3	Actual value of oxidation air mass flow controller out of tolerance window
9	ER09 - MFC4	Actual value of quench air mass flow controller out of tolerance window
10	ER10 - MFCS	Actual values of some mass flow controllers out of tolerance window
11	ER11 - MFCA	Actual values of all mass flow controllers out of tolerance window
12	ER12 - BUPR	Burner differential pressure above 500mbar
13	ER13 - EMER	Stop on emergency
14	ER14 - SSP	System error caused by synchronous serial port
15	ER15 - HRS	System error caused by operating hours overflow
16	ER16 - SWTO	System error caused by timeout of connected GUI software
17	ER17 - STFL	Flow error during start sequence
18	ER18 - WROP	Error when setting operating point
19	ER19 - ILST	Emergency shutdown or power loss
20	ER20 - NVOP	No valid operating point defined
21	ER21 - IGNF	Ignition failure

If the testo REXS GUI is connected to testo REXS, the error is also displayed in a error window. Shut down Testo REXS, locate the error source, fix the error and then click OK.

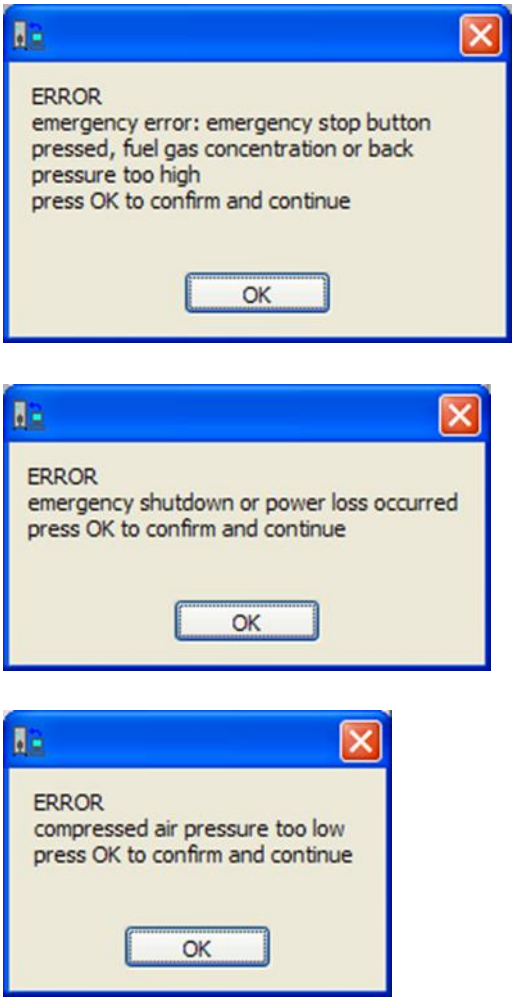


Fig. 7.7: Error message window (examples)

Some errors are not displayed on the testo REXS front panel display, as they do not affect safe operation. These errors are associated with communication between testo REXS and the testo REXS GUI.

error code	name	error description
128	ERR_RS232_PARITY	Parity error on serial communication
129	ERR_RS232_ADRRANGE	Serial command address field out of range
130	ERR_RS232_LENRANGE	Serial command data length out of range
131	ERR_RS232_FRAMEREAD	Serial command framing error while reading
132	ERR_RS232_FRAMEWRIE	Serial command framing error while writing
133	ERR_RS232_TIMEOUT	Serial command timeout error
134	ERR_RS232_ACCESS	Serial command read/write access error
135	ERR_RS232_INVALIDOP	Attempt to set invalid operation point

Table: Error messages not on testo REXS display

If the testo REXS GUI is connected to testo REXS, the error is displayed in an error window. Shut down testo REXS, locate the error source, fix the error and then click *OK*

8 Appendix

8.1. Specification, Technical Data

Aerosol	Soot nanoparticles generated in combustion process
Particle mass output	Approx. 1.5 g/h at 90 nm particle diameter
Particle number concentration	10^7 - 10^8 particles/cm^3
Particle size	Several monomodal distributions with mode diameter of approx. 30 nm to 120 nm
Particle size distribution	Monomodal lognormal, with geometric standard deviation approx. 1.5 to 1.7 for particle size between 30 nm and 60 nm; Monomodal, geometric standard deviation approx. 1.8 to 1.9 for particle size between 60 nm and 120 nm.
Test aerosol flow output	300 - 700 l_N/min at different particle diameters, approx. 150 l_N/min in standby mode
Back pressure	Up to 500 mbar above atmospheric pressure
Gas Supply Specifications	- C_3H_8 (propane), purity 99,95 % (grade 35), up to 2 l_N/min at 5 bar - N_2 (nitrogen), purity 99,999 % (grade 50), up to 2 l_N/min at 5 bar - Compressed air, dry (< 2% relative humidity at 23 °C, dew point approxi- mately -28 °C), clean (5 µm filtered) and oil free air, up to 1000 l_N/min at 7 bar
Gas interfaces	- Orange: C_3H_8: encoded quick coupling, orange with tube and excess flow valve. 6 mm tube fitting at supply end. - Black: N_2: encoded quick coupling, orange with tube and excess flow valve. 6 mm tube fitting at supply end. - Compressed air: Legris ISO B8, safety quick coupling plug at supply end.
Power Supply	100-230 VAC (±10V of nominal voltage) / 50-60 Hz, max. 600 VA
Aerosol interface	DN 50 ISO KF small flange, 50 mm nominal width.
Exhaust suction	Min. 1000 l_N/min, with backup HEPA filter
Safety features	Optical flame detection sensor in the burner. Pressure sensor and pressure switch stop testo REXS if the pressure inside the burner exceeds 500 mbar. Gas detector inside testo REXS initiates gas alarm and emergency stop if C_3H_8 concentration exceeds 0.1% / 1.0 %. Leak protective valves in all gas lines. Microcontroller watchdog timer supervises correct function and shuts down testo REXS if program fails.
Local operation	2 buttons, dot matrix display, LED indicators

Remote operation	PC remote control through EIA 232 serial interface, software included
External emergency stop	Opening contacts
Assembly	- Mobile 19”-rack - blockable castors - carrier for 3 compressed cylinders of 10 liters each - slide to adjust aerosol output position - drawer for laptop PC and drawer for accessories
Weight	Approx. 130 kg
Operating temperature	T_{amb}: 15 to 35 °C 10 to 90%, non-condensing
Calibration	Gravimetric analysis of aerosol filter samples SMPS size distribution analysis
PC or Notbook requirements	Minimal requirements are: - Windows 2000, Windows XP, Windows Vista - CPU Speed: 500 MHz - Internet Explorer 6 - 1 RS232 serial interface with 9 pin D-Sub connector - 64 MB RAM - CD drive - 30 MB free hard disk space
Conformity	Conformity with all applicable standards of the European regulation, CE Safety: EN 61010: 2001 referring to voltage directive 2006/95/EG EMC conformity - emission EN 61326: 2006, Class A - immunity EN 61000: 2001 industrial level - EM Safety: EN 50371: 2002 referring to EMC directive 2004/108/EG FCC class B part 15, subpart B

8.2. Service Guide

8.2.1. Cleaning of the Burner Outlet

The burner outlet gets contaminated by soot after some operating hours. Clean the burner outlet after approximately 40 hours of operation. Remove the tubing attached and clean it using a dry towel. To clean the burner outlet, loosen the 4 M4 Torx screws that are accessible from the top of the burner. Use a T20 screwdriver. Take care not to spill soot to the inside of the burner. Then clean the burner outlet using a dry towel. It is normal that a slight black stain remains on the tubing surface even after cleaning. After having cleaned all surfaces, re-attach the burner outlet to the top of the burner and fasten the 4 screws. Take care that the O-ring sealing is held in its correct position and is not crushed.

8.2.2. Cleaning of the Spark Ignition Electrode

The automatic flame ignition uses a high voltage spark. The electrode has to be cleaned periodically to enable safe and proper operation. Clean the electrode after approximately 40 hours of operation. Switch off power and remove all gas connections and the power cord. To remove the electrode, loosen the 3 M4 Torx screws that hold the pneumatic cylinder to the electrode case. Use a T20 Torx® screw-driver. Pull out the electrode together with the pneumatic cylinder. Clean the electrode tips and the concave ceramic surface using a dry towel or a fine brush. Re-attach the electrode and pneumatic cylinder. Take care not to damage the sealings. Fasten the screws.

8.2.3. Exchange of the HEPA Gas Filter Cartridges

Propane, nitrogen and air are filtered individually by HEPA filters. Though the gases are quite pure themselves, the filter cartridges have to be replaced only once in a year. The filter cartridge exchange has to be done by service personal from your local contractor.

Filter cartridges to be exchanged:

Filter	Location	Exchange interval
propane (C_3H_8)	testo REXS control insert	1 year
nitrogen (N_2)	testo REXS control insert	1 year
compressed air prefilter	testo REXS rack	1 year
compressed air HEPA	testo REXS rack	1 year
compressed oxidation air prefilter	testo REXS control insert	1 year
compressed oxidation air HEPA	testo REXS control insert	1 year

8.2.4. Exchange of the Spark Ignition Electrode

To remove the electrode, loosen the 3 M4 Torx screws that hold the pneumatic cylinder to the electrode case. Use a T20 screw-driver. Pull out the electrode together with the pneumatic cylinder. Attach the new spark ignition electrode to the pneumatic cylinder. Take care not to damage the sealings. Fasten the screws.

8.2.5. Cleaning of the Optical Flame Detection Unit

1. Disconnect testo REXS from electrical power and all gas lines. Let the system cool down.
2. Remove the protection cover that covers the burner (if mounted).
3. Disconnect the plug X302 (11.5 mm diameter 4 pin plug) from the small steel case at the bottom of the burner.
4. Loosen the 4 M3 TORX® screws that attach the steel case to the transparent cover. Use a T10 TORX® screwdriver. Remove the steel case carefully and disconnect the white 4 pin PCB connector.
5. Loosen the M3 nuts that attach the PCB to the spacer bolts. Bend the PCB to the side carefully. Do not stress or kink the wires that lead to the optical sensor!
6. Loosen the 4 M3 TORX® screws that attach the transparent cover to the burner bottom. Use a T10 TORX® screwdriver. Remove the transparent cover and the optical sensor. Do not lose the O-ring sealing or any other small parts!
7. Clean the burner bottom part. Use a vacuum cleaner or disconnect the steel mantled hose and use compressed air.
8. Clean the optical sensor. Use a dry towel.
9. Re-assemble the transparent cover, the sensor and the sealings to the burner bottom. Toghten all screws with care.
10. Mount the PCB to the spacer bolts. Fasten the nuts.
11. Connect the white 4 pin PCB connector, carefully assemble the steel case and fasten the screws.

12. Connect the plug X302 to the socket.
13. Re-attach the protection cover of the burner.
14. Connect testo REXS to all gas lines and to electrical power.

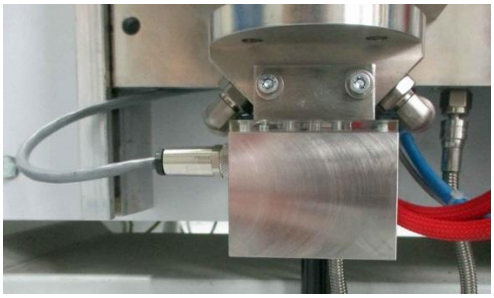


Fig. 8.1: Flame detector

8.3. Definitions, Units and Conversion Table

Pressure		Pascal	Bar	Pound per square inch			
		(Pa)	(bar)	(psi)			
	1 Pa	1	$1.0 \cdot 10^{-5}$	$1.450 \cdot 10^{-4}$			
	1 bar	$1.0 \cdot 10^{5}$	1	14.504			
	1 psi	6 894.8	0.0689	1			
Length		**Meter**	**Centimeter**	**Millimeter**	**Micro-meter**	**Nanometer**	**Inch**
		(m)	(cm)	(mm)	(µm)	(nm)	(") = (in)
	1 m	1	100	1 000	$1.0 \cdot 10^{6}$	$1.0 \cdot 10^{9}$	39.37
	1 cm	0.01	1	10	$1.0 \cdot 10^{4}$	$1.0 \cdot 10^{7}$	0.3937
	1 mm	0.001	0.1	1	1 000	$1.0 \cdot 10^{6}$	0.0394
	1 µm	$1.0 \cdot 10^{-6}$	$1.0 \cdot 10^{-4}$	1.001	1	1 000	$3.937 \cdot 10^{-5}$
	1 nm	$1.0 \cdot 10^{-9}$	$1.0 \cdot 10^{-7}$	$1.0 \cdot 10^{-6}$	0.001	1	$3.937 \cdot 10^{-8}$
	1 " = 1 in	0.0254	2.54	25.4	$2.54 \cdot 10^{4}$	$2.54 \cdot 10^{7}$	1
Temperature		**Celsius**	**Fahrenheit**				
		(°C)	(°F)				
	0 °C	0	32	T[°C] = (T[°F]-32)/1.8			
	100 °C	100	212	T [°F] = T[°C] · 1.8 + 32			
	0 °F	-17.78	0				
	100 °F	37.78	100				
Mass		**Kilogram**	**Gram**	**Pound**	**Ounce**		
		(kg)	(g)	(lb)	(oz)		
	1 kg	1	1 000	2.205	35.27		
	1 g	0.001	1	0.0022	0.0353		
	1 lb	0.4536	453.6	1	16		
	1 oz	0.0283	28.35	0.0625	1		
Volumetric		**Cubic Meter**	**Liter**	**Milliliter**	**Cubic Inch**	**Cubic Foot**	

		(m3)	(l)	(ml) = (ccm)	(cin)	(cft)	
	1 m^3	1	1 000	$1.0 \cdot 10^6$	61 024	35.315	
	1 l	0.001	1	1000	61.024	0.0353	
	1 ml = 1 ccm	$1.0 \cdot 10^{-6}$	0.001	1	0.0610	$3.531 \cdot 10^{-5}$	
	1 cin	$1.639 \cdot 10^{-5}$	0.0164	16.387	1	$5.787 \cdot 10^{-4}$	
	1 cft	0.0283	28.317	$2.832 \cdot 10^4$	1728	1	

Volumetric flow							
		(l / min)	(m^3 / h)				
	1 l_N / min	1	0.060				
	1 m^3 / h	16.667	1				
	1 l_N =	1 standard liter at 0 °C, 1 013.25 hPa					

Units													
	Length	m	meter	cm	centi-meter	mm	milli-meter	nm	nano-meter				
	Mass	kg	kilo-gram	g	gram								
	Time	h	hour	min	minute	s	second						
	Electri-city	A	ampère	V	volt	VA	volt-ampère	Ω	ohm				

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