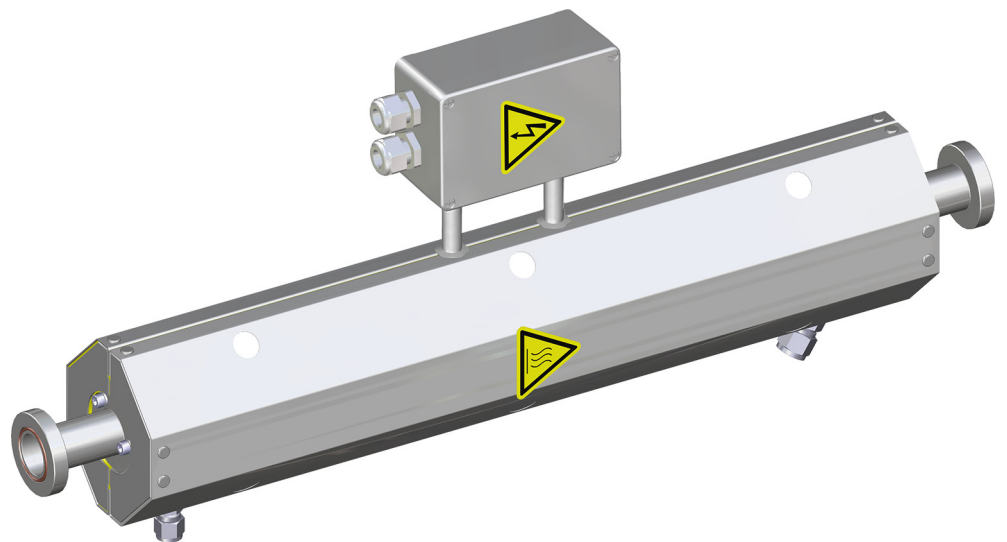


Operating Instructions

AGK

Gas Cell



Described product

Product name: AGK

Manufacturer

Endress+Hauser SICK GmbH+Co. KG
Bergener Ring 27
01458 Ottendorf-Okrilla
Germany

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1	Important information	5
1.1	Symbols and document conventions	5
1.1.1	Warning symbols.....	5
1.1.2	Warning levels and signal words.....	5
1.1.3	Information symbols	5
1.2	Main hazards.....	6
1.3	Intended use	6
1.3.1	Purpose of the cell.....	6
1.3.2	Limitations	6
1.4	Responsibility of user.....	6
2	Product description	7
2.1	Product identification	7
2.2	Layout and function	7
2.2.1	Materials used	7
2.2.2	Thermostatic control.....	8
3	Mounting and electrical installation	9
3.1	Mounting	9
3.1.1	Connecting sample gas	10
3.2	Electrical installation.....	12
3.2.1	Electrical connection	12
4	Commissioning / operation	14
4.1	Commissioning.....	14
4.1.1	Safety information on commissioning	14
4.1.2	Restrictions of use	14
4.1.3	Start-up procedure.....	14
4.2	Operation.....	15
5	Decommissioning.....	16
5.1	Decommissioning.....	16
5.2	Disposal	16
6	Maintenance.....	17
6.1	Maintenance plan	17
6.2	Recommended spare parts for 2 years operation.....	18
6.3	Removing the cell from the MCS300P gas analyzer	18
6.4	Installing the cell on the MCS300P gas analyzer	18
6.5	Replacing the window and O-rings	19
6.5.1	Removing the flanges.....	20
6.5.2	Installing windows and seals	21
6.5.3	Installing the flanges	21
6.6	Cleaning/replacing the filter element	22
6.6.1	Removing the filter element.....	22
6.6.2	Installing the filter element	23

6.7	Removing and installing the insulating housing	24
6.7.1	Removing the cell from the insulating housing	24
6.7.2	Installing the cell in the insulating housing.	25
7	Clearing malfunctions.....	26
7.1	Clearing malfunctions.....	26
7.2	Safety temperature limiter has triggered.	26
8	Technical specification	27
8.1	Compliance	27
8.1.1	Electrical protection	27
8.2	Dimensions	28
8.2.1	Dimensions AGK50, AGK75, AGK75 HT	28
8.3	Technical data	29
8.3.1	Cable glands.....	30
8.3.2	Connection terminals	30
8.3.3	Torques	31

1 Important information

1.1 Symbols and document conventions




1.1.1 Warning symbols

Symbol	Significance
	Hazard (general)
	Hazard by voltage
	Hazard in potentially explosive atmospheres
	Hazard by noxious substances
	Hazard by hot surfaces

1.1.2 Warning levels and signal words

DANGER: Risk or hazardous situation which <i>will</i> result in severe personal injury or death.
WARNING: Risk or hazardous situation which <i>could</i> result in severe personal injury or death.
CAUTION: Hazard or unsafe practice which <i>could</i> result in less severe or minor injuries.
NOTE: Hazard which <i>could</i> result in property damage.

1.1.3 Information symbols

Symbol	Significance
	Information on product condition with regard to explosion protection
	Important technical information for this product
	Important information on electrical or electronic functions

1.2 Main hazards



CAUTION: Noxious and irritating sample gases

When the sample gas contains noxious or irritant substances:

- ▶ Operate the AGK in a safe manner
- See [“Safety information on commissioning”](#), page 14



WARNING: Risk of explosions in potentially explosive atmospheres

- ▶ Do not use the AGK in potentially explosive atmospheres.



WARNING: Hazards by ignitable or combustible gases

- ▶ Do not use the AGK to measure ignitable or combustible gases.

1.3 Intended use

1.3.1 Purpose of the cell

The cell is part of a measuring system for analyzing gas mixtures and is used exclusively for the spectrometric analysis of gases under process conditions.

1.3.2 Limitations

- ▶ Check whether the cell is suitable for the sample gas composition planned.
 - List with materials used in the cell: Refer to the Data Sheet delivered with the cell.
 - In case of doubt, contact your local Endress+Hauser Sales Office.

1.4 Responsibility of user

Designated user

The cell may only be operated by skilled technicians who, based on their technical training and knowledge as well as knowledge of the relevant regulations, can assess the tasks given and recognize the hazards involved.

Correct use

- ▶ Use the cell only as described in these Operating Instructions. The manufacturer bears no responsibility for any other use.
- ▶ Have the prescribed maintenance work performed.
- ▶ Do not remove, add or modify any components in or on the cell. Otherwise:
 - The cell can become dangerous.
 - Any warranty by the manufacturer becomes void.

Special local conditions

- ▶ In addition to the Operating Instructions, observe all local laws, technical regulations and company-internal operating directives applicable at the installation location of the device.

Further documents

- Operating Instructions of MCS300P (for mounting the cell on an MCS300P).

Keeping documents

- ▶ Keep these Operating Instructions available for reference and pass them on to new owners.

2 Product description

2.1 Product identification

Manufacturer:	Endress+Hauser SICK GmbH+Co. KG Bergener Ring 27 · 01458 Ottendorf-Okrilla · Germany
Cell	Part No.
AGK50 (50 cm) ^[1]	2024474
AGK75 (75 cm)	2054587
AGK75 HT (75 cm) high-temperature	2082470

[1] Optical path length

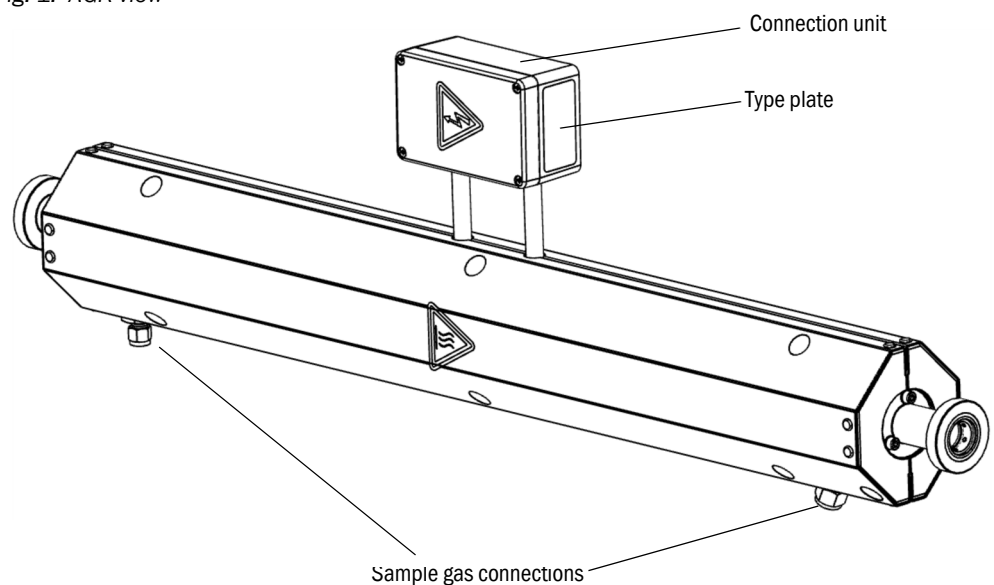
The type plate is located on the connection unit (see “AGK view”, page 7).

2.2 Layout and function

The sample gas is channeled through a sample compartment limited by windows on the side.

The measuring beam of a connected analyzer travels lengthwise through the cell and through the sample compartment. The measuring beam is attenuated by the sample gas, depending on the sample gas in a gas-specific manner and the analyzer evaluates this attenuation.

Fig. 1: AGK view



2.2.1 Materials used

Different materials are used for the windows and seals depending on the spectral range and application conditions.

- The cell can be used for reactive and corrosive gases depending on the materials used.
- The maximum operating pressure depends on the materials used.



▶ Refer to the Data Sheet delivered with the cell for the materials used.

2.2.2 Thermostatic control

The cell has an integrated heating.

The temperature is usually controlled via the MCS300P analyzer.

A safety temperature limiter is integrated for thermal protection of the cell. See [“Removing the insulating housing”](#), page 24.

3 Mounting and electrical installation

3.1 Mounting



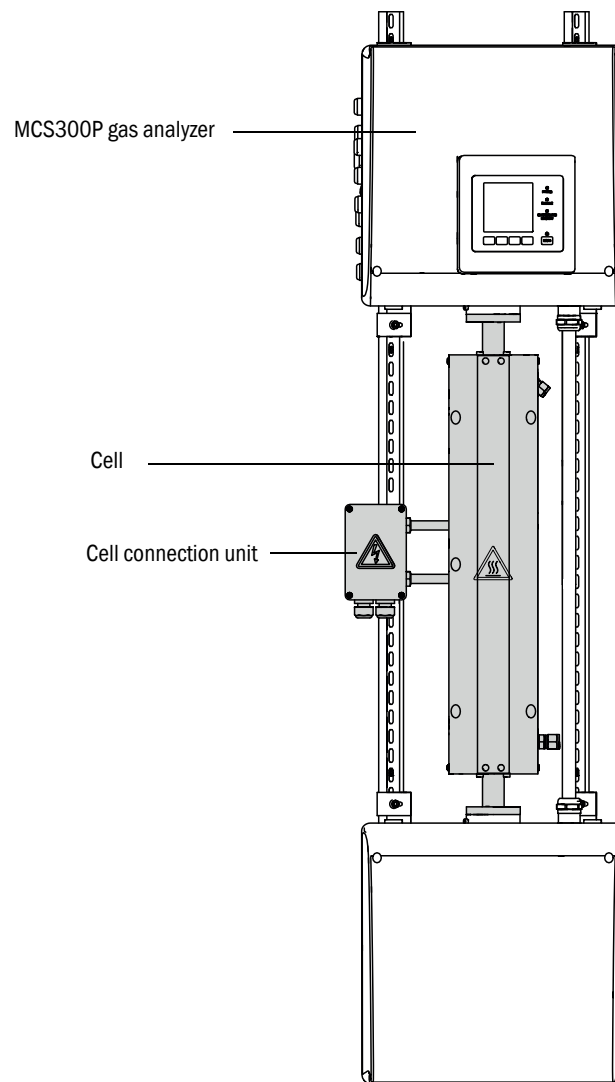
WARNING: Risk of explosions

- ▶ Do not use the AGK in potentially explosive atmospheres and do not use for measuring combustible gases.

The AGK is usually installed on the Endress+Hauser MCS300P analyzer.

The positions of the measuring beam inlet and outlet are arbitrary.

Fig. 2: View (example): Cell on the MCS300P gas analyzer



If you have to install the cell yourself: → Operating Instructions of the MCS300P.

Final mounting steps:

- 1 Connect sample gas. See “Connecting sample gas”, page 10.
- 2 Connect purge gas (option).
- 3 Electrical installation. See “Electrical installation”, page 12.

3.1.1 Connecting sample gas

Gas connections may only be performed by skilled persons who, based on their technical training and knowledge:

- Are familiar with handling pipes and pipe connections.



NOTE: Damage through condensate

Condensate can form on the sample gas outlet when using wet and hot sample gas.

- ▶ Keep the line opening free from any blockages.
- ▶ Always lay the line so that it runs downwards and no condensate can occur.
- ▶ Protect the sample gas outlet from frost.
- ▶ If necessary, provide a suitable condensate collecting device and adequate ventilation.

Check and empty the condensate collection container regularly.



NOTE: Damage resulting from overpressure.

Blocked pipes can falsify measured values and possibly damage the cell.

- ▶ The sample gas outlet may not increase the working pressure.
 - ▶ Only use pipes and pipe screw fittings that are adequate for the required pressure.
 - ▶ Do not bend or crimp the pipes.
-

3.1.1.1 Preparation work



WARNING: Danger to life/health risk by noxious gases

If noxious gases are applied to the cell, emerging gas can damage health.

- ▶ Lay the cell outlets into the open or into a suitable collecting channel.
- ▶ Pay attention to the information from the equipment operator.

A leak in the gas path can create acute danger for persons.

- ▶ Take suitable safety measures.
-



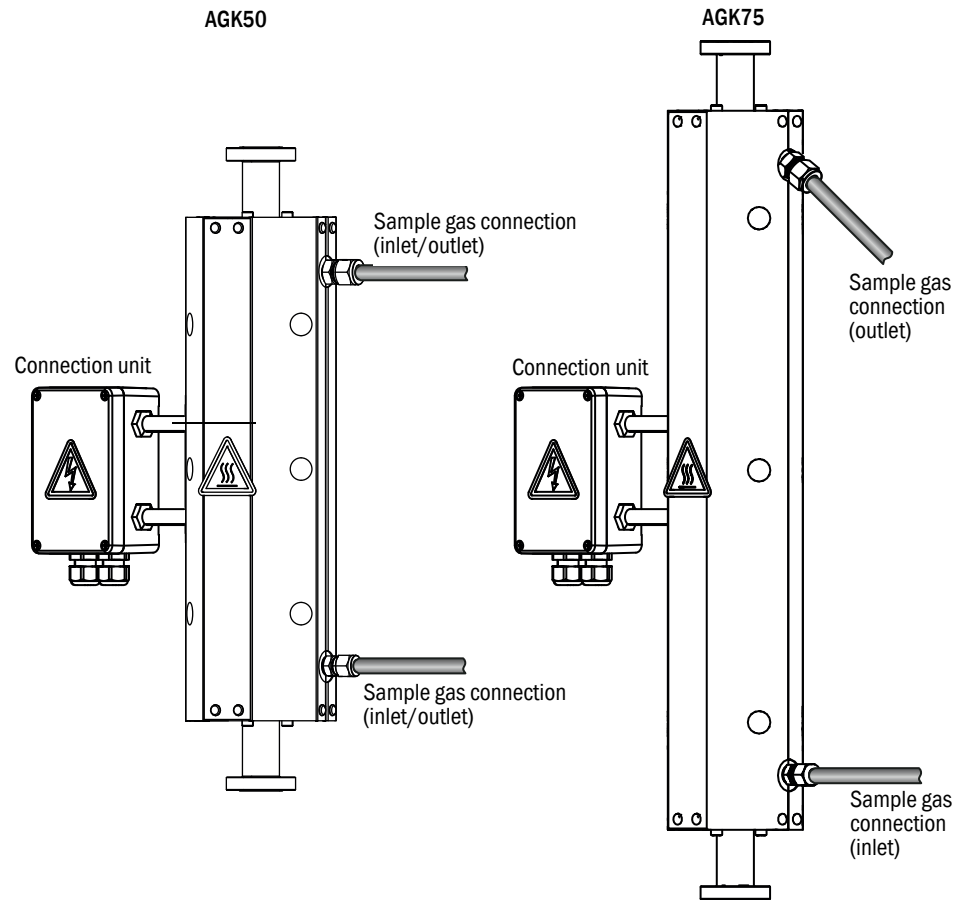
NOTE: Possibly provide initial thermal stabilization for cold sample gas

When cold sample gas is fed to a heated cell, it is possible that the measurement signal becomes unstable due to thermal turbulence.

- ▶ Plan suitable initial thermal stabilization when necessary, e.g. by using a heated sample gas line.
-

3.1.1.2 Connecting the sample gas

Fig. 3: AGK sample gas connection: Recommended installation)

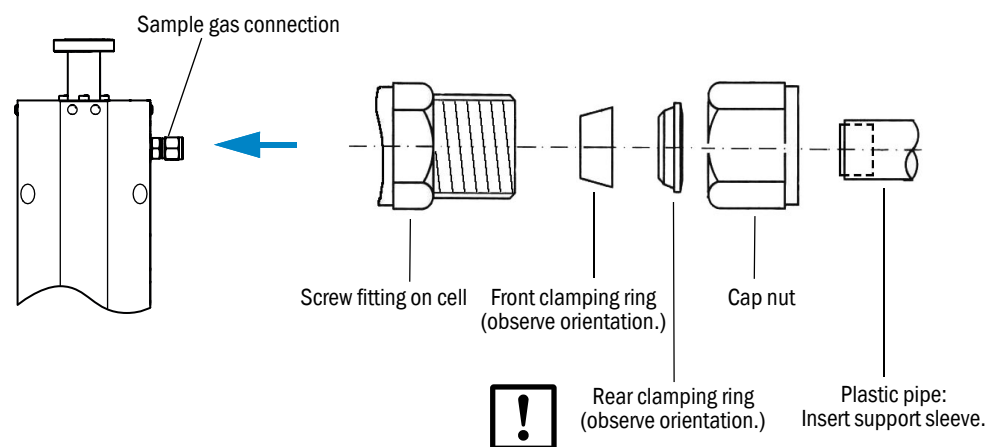


- ▶ Connect the sample gas pipes gas-tight as shown in the schematic diagram.
 - *Vertical mounting*: Sample gas inlet below, sample gas outlet above (recommended).
 - *Horizontal mounting*: Pay attention to correct sample gas inlet and sample gas outlet.

Information: Only use suitable pipes for the sample gas, e.g. PTFE pipes.

Information on plastic pipes: Use support sleeves.

Fig. 4: Clamping ring screw connection (sample gas connection)



3.2 Electrical installation

An electrical installation is only necessary if the cell is to be heated.

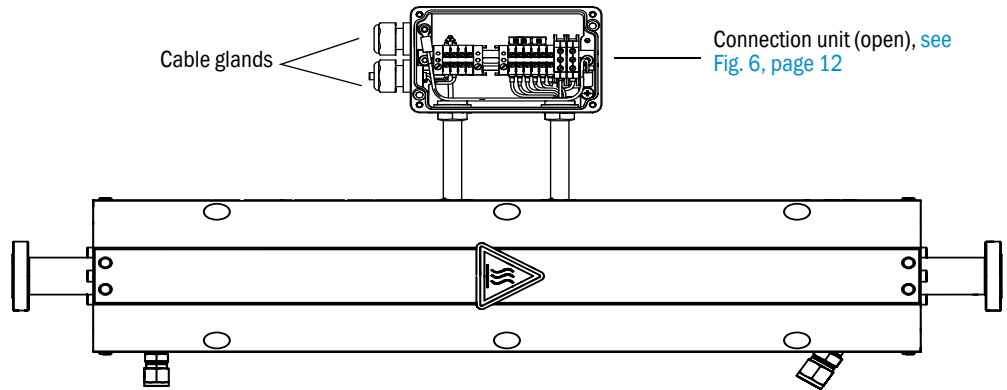


WARNING: Hazard by voltage

The electrical connection of the AGK may only be made by skilled technicians who, based on their technical training and knowledge as well as knowledge of the relevant regulations, can assess the tasks given and recognize the hazards involved.

3.2.1 Electrical connection

Fig. 5: Connection unit with electrical connections



- 1 Loosen screws (4) on the connection unit cover.
- 2 Take the cover off.



A wiring diagram is in the connection unit cover.

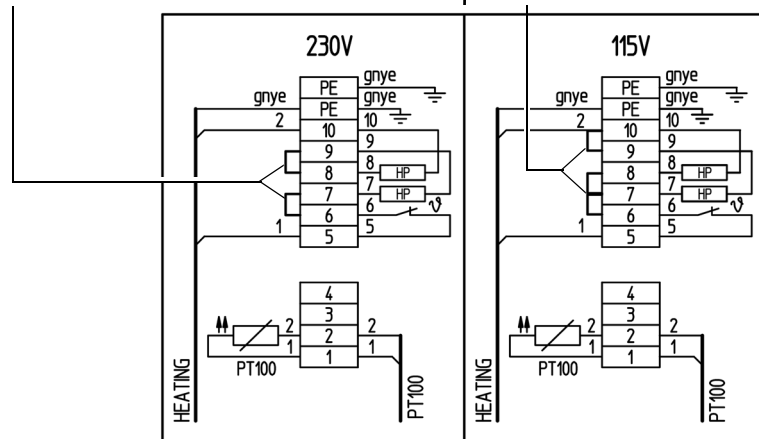
Fig. 6: Pin assignment for 230 V and 115 V supply

Jumpers for 230 V voltage supply:

- Terminals 6 – 7
- Terminals 8 – 9

Jumpers for 115 V voltage supply:

- Terminals 6 – 7 – 8
- Terminals 9 – 10



- 3 Check position of jumpers for voltage setting.



NOTE: Pay attention to jumpers

- ▶ Jumpers depend on the line voltage.

-
- 4 Lead the connection cables for input voltage and Pt100 through cable glands and connect them in the connection unit (specification [see "Technical data"](#)).
 - ▶ Pay attention to the clamping range and tightening torque of the terminal connections and cable glands (specification, [see "Technical data"](#)).
 - ▶ Observe cable routing for horizontal installation.
 - ▶ Keep cables away from hot surfaces, secure cables accordingly!
 - ▶ Use temperature-resistant connection cables, e.g. PTFE, for high-temperature cells AGK HT.
 - 5 Tighten the cable glands.
 - 6 Fit and tighten the connection unit cover.
 - 7 Connect the cell to the external temperature control.

4 Commissioning / operation

4.1 Commissioning

4.1.1 Safety information on commissioning



WARNING: Hazards by explosive or combustible gases

- ▶ Do not use the AGK to measure ignitable or combustible gases.



WARNING: Mortal/health danger as a result of gas path leakage

When noxious gases are fed to the cell:

A leak in the gas path can create an acute danger for persons.

- ▶ When required, carry out a leak test.

4.1.2 Restrictions of use

- ▶ Check whether the cell is suitable for your sample gas composition.
 - For a list of materials used in the cell, refer to the Data Sheet delivered with the cell.
- ▶ If in doubt, please contact Endress+Hauser or their local organization.

4.1.3 Start-up procedure

- 1 Check sample gas feed for:
 - Damage
 - Leak tightness
 - Continuity
 - Functional capability of sample gas filter
 - Correct sample gas pressure setting
 - When heated: Functional capability of heater
 - Correct cell temperature setting
- 2 Let the cell heat up.
 - Max. sample gas temperature of AGK50 and AGK75: 200 °C (392 °F)
 - Max. sample gas temperature of AGK75-HT: 230 °C (445 °F).



There is a risk of condensation in the cell when gas is fed to a cold cell.

- ▶ Let the cell heat up.
- ▶ Then feed sample gas.

- a) When used under ambient temperature without heating:
 - Allow the cell to adapt to the gas temperature for approx. 5 h.
- b) When using the cell heating:
 - Check the setting of the temperature control.
 Heating up time:
 - From room temperature to approx. 50 °C (120 °F): Approx. 1 h
 - From room temperature to approx. 200/230 °C (392/445 °F): Approx. 2 h
- 3 Feed sample gas.

When the cell is operated with pressure: Apply pressure slowly.

 - Max. pressure: [see "Technical data", page 29](#)
 Set the sample gas flow rate:
 - Recommended flow rate: 30 ... 1000 l/h (1 ... 35.31 ft³/h)

4.2 Operation

**DANGER: Risk of burns on hot surface**

Cell and gas connections can be very hot.

- ▶ Do not touch the surface.
-

The cell operates automatically.

In regular intervals:

- ▶ Check the cell and connected pipes for:
 - Damage
 - Leak tightness
 - Continuity

5 Decommissioning

5.1 Decommissioning



WARNING: Hazard resulting from substances remaining in the cell

Depending on the sample gas composition, toxic or corrosive gases can remain in the cell and connected pipes when the gas supply is switched off. If necessary:

- ▶ Purge the cell and connected pipes for at least 1 h with inert gas (e.g.: N₂).
- ▶ Take suitable protective measures (e.g. work under a vent, wear suitable protective clothes).
- ▶ Decontaminate the cell.

- 1 Switch off the sample gas feed and ensure that no more gas can flow into the cell.
- 2 Depending on the sample gas composition, purge the cell and connected pipes for at least 1 h with inert gas.
- 3 Ensure that the sample gas lines are depressurized.
- 4 Switch purge gas off when used.
- 5 If heating is connected: Switch the heating off and disconnect where necessary.
- 6 If the cell is to be put out of operation for a longer period:
 - ▶ Close the gas inlets airtight.



WARNING: Risk of burns on hot surface

Cell and gas connections can be very hot.

- ▶ Allow the cell and gas connections to cool down before touching them.



WARNING: Danger when storing or dispatching

If the cell can contain deposits dangerous to health and the cell is to be stored or sent somewhere:

- ▶ Mark the cell *clearly*:
 - Which gases were in the cell.
 - Which hazards exist (e.g. when disassembling the cell).
 - How the cell was cleaned.

5.2 Disposal

- ▶ Observe local regulations.
- ▶ Dispose of electronic components as electronic waste.
- ▶ Dispose of metal parts as scrap metal.
- ▶ Dispose of windows and seals as residual waste.
- ▶ If the cell was used with toxic substances or substances harmful to the environment and there is a risk that deposits of these substances still cling to parts with media contact: Dispose of parts with media contact as hazardous waste.

6 Maintenance

6.1 Maintenance plan

Maintenance intervals

Maintenance interval	Maintenance work
1 year	<ul style="list-style-type: none"> ▶ Disassemble and clean the cell. <p><i>Recommendation:</i></p> <ul style="list-style-type: none"> ▶ Replace O-rings that come into contact with the sample gas ▶ Renew the cell windows (could be severely damaged during disassembly). ▶ Replace the sample gas inlet filter.
2 years	<ul style="list-style-type: none"> ▶ Additionally: Replace the O-rings and set of windows in the sample gas flange.



NOTE: Malfunction hazard

Maintenance work on the cell may only be carried out by skilled persons trained on the cell.

6.2 Recommended spare parts for 2 years operation



WARNING: Malfunction hazard
 ▶ Use original Endress+Hauser spare parts only.

Assembly kits	Quantity ^[1]	Y ^[2]	2Y ^[3]	Part No.
Gas cell aluminum 50/75 cm				
Filter spare parts set	1		●	2082610
Maintenance kit filter AGK 15 µm, consisting of: – O-ring 18 x 1 for screw-in fitting – O-ring 15.6 x 1.78 for filter housing 15.6 x 1.78 – Filter element 15 µm – Spring	1	●		2056853
1 set window, O-ring, sealing ring; BaF2 window	2	●		2024857
1 set window, O-ring, sealing ring; CaF2 window	2	●		2024858
1 set window, O-ring, sealing ring; IG2 window	2	●		2024856
1 set window, O-ring, sealing ring; AgCl window	2	●		2024480
1 set window, O-ring, sealing ring; quartz window	2	●		2024861
Gas cell aluminum 75 cm HT				
Filter spare parts set	1		●	2082610
Maintenance kit filter AGK-HT 15 µm, consisting of: – O-ring 18 x 1 for screw-in fitting – O-ring 15.6 x 1.78 for filter housing – Filter element 15 µm – Spring	1	●		2082784
1 set window, O-ring, sealing ring; BaF2 window	2	●		2024859
1 set window, O-ring, sealing ring; CaF2 window	2	●		2082612
1 set window, O-ring, sealing ring; quartz window	2	●		2082614

[1] Number of sets per maintenance
 [2] Recommendation: Renew yearly
 [3] Recommendation: Renew every 2 years

6.3 Removing the cell from the MCS300P gas analyzer



Removing the cell from the MCS300P → Operating Instructions of the MCS300P

6.4 Installing the cell on the MCS300P gas analyzer

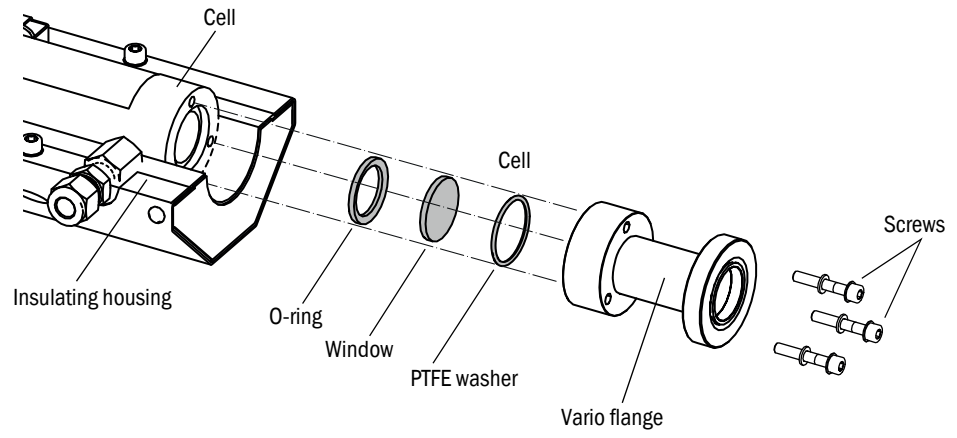
The cell is normally operated on an MCS300P.



Fitting the cell on an MCS300P: → Operating Instructions of the MCS300P

6.5 Replacing the window and O-rings

Fig. 7: Illustration of the window and the sealing elements of the cell

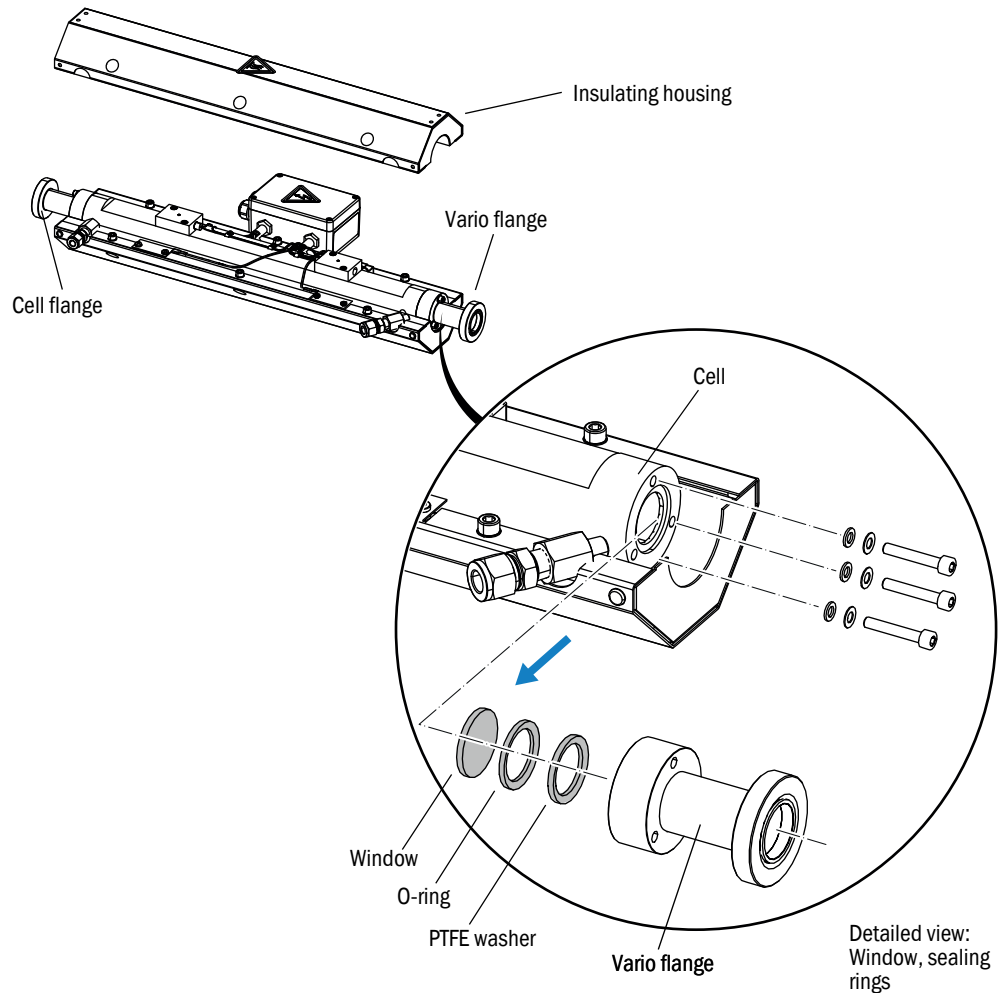


6.5.1 Removing the flanges

**NOTE:**

- ▶ Make sure the cell windows do not fall out during removal.
- ▶ Protect windows from contamination and damage.

Fig. 8: Window and sealing rings on the Vario flange



- 1 Remove the insulating housing.
 - ▶ Loosen the screws of the cover (6 pcs).
 - ▶ See Section 6.7.1.
- 2 Unscrew 3 screws (hexagon socket M4) on the Vario flange.
- 3 Remove the Vario flange (sealing rings may stick).
- 4 Remove the windows and sealing rings or sealing elements (e.g. using a suction cup). Use new windows and seals.

**NOTE:**

- ▶ Do not touch cell windows with your fingers (wear gloves, if required) and do not contaminate the windows.

6.5.2 Installing windows and seals

See “Window and sealing rings on the Vario flange”, page 20.

- 5 Clean the sealing surfaces carefully.
 - If necessary, use cotton swabs or wooden sticks for cleaning, and possibly isopropanol.
 - Use new O-rings.
Make sure O-rings are made of the correct material.
- 6 Carefully insert the O-ring into the cell.



NOTE: Make sure the cell is clean

The inside of the cell must be clean before assembly.
Cleaning agent residues could affect measurement.

The windows must be clean.

- ▶ Do not touch the windows with your fingers.
-

- 7 If necessary, clean the windows carefully with a soft cloth.
Suitable cleaning agents (depending on the sample gas):
 - Demineralized water
 - IsopropanolDo not use any other cleaning agents and no scouring cloths.
Carefully dry the windows after cleaning (no marks should remain).
- 8 Place the cell upright and insert the window into the cell.
- 9 Insert the PTFE sealing washer into the Vario flange.
Note: Direction of the sealing ring: Chamfered side on the flange side - flat side on the window side.

6.5.3 Installing the flanges



NOTE:

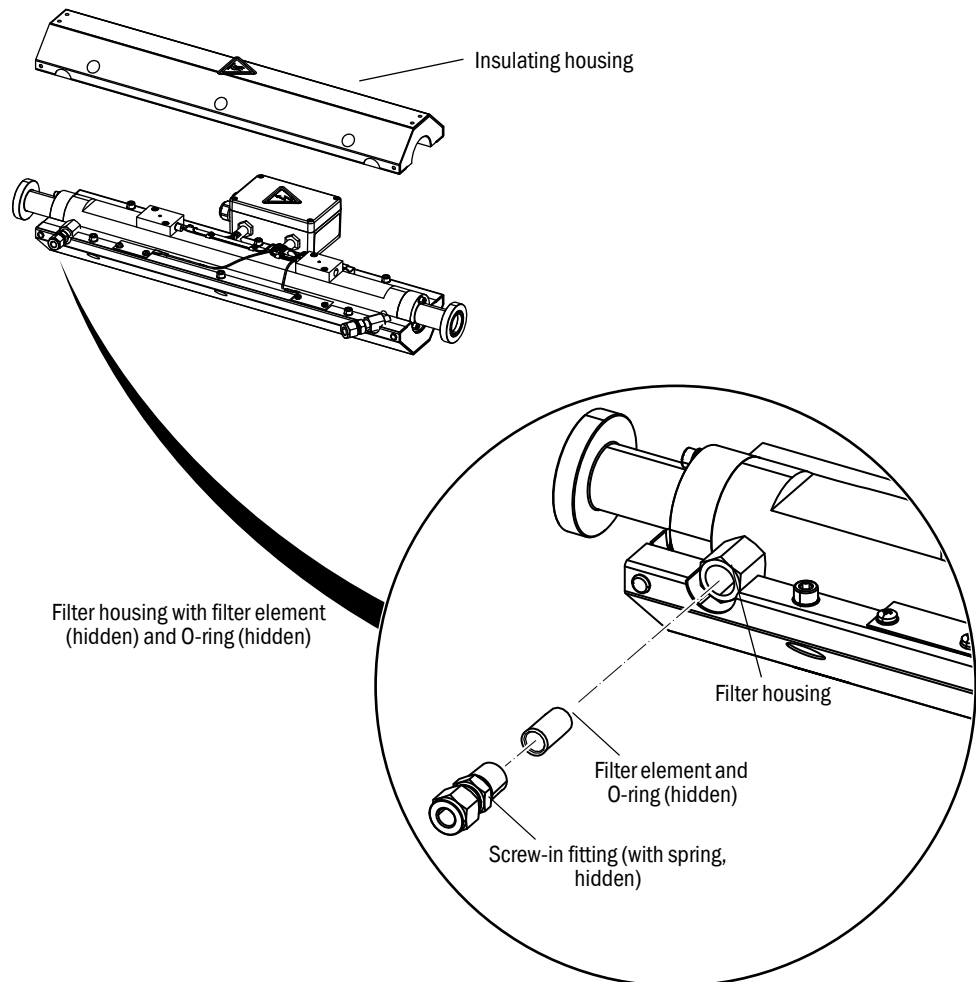
When assembling the flange, make sure that the window does not fall out.

- 1 Place the Vario flange on the cell and tighten evenly by hand with 3 screws.
- 2 Perform a suitable leak test, when required.

6.6 Cleaning/replacing the filter element

See “Removing the insulating housing”, page 24

Fig. 9: Filter element (disassembled)



6.6.1 Removing the filter element

- 1 Unscrew the gas pipe (gas inlet).
- 2 Remove the insulating housing.
See “Removing the cell from the insulating housing”, page 24.
 - Unscrew the screw-in fitting from the filter housing (wrench SW22).
Hold the filter housing with an open-end wrench (wrench SW24).
- 3 Carefully unscrew the screw-in fitting.
Note: Screw-in fitting contains a spring, remove this as well.
- 4 Remove the O-ring.
- 5 Unscrew the filter housing (wrench SW24).
- 6 Remove the O-ring.
- 7 Remove the filter element.

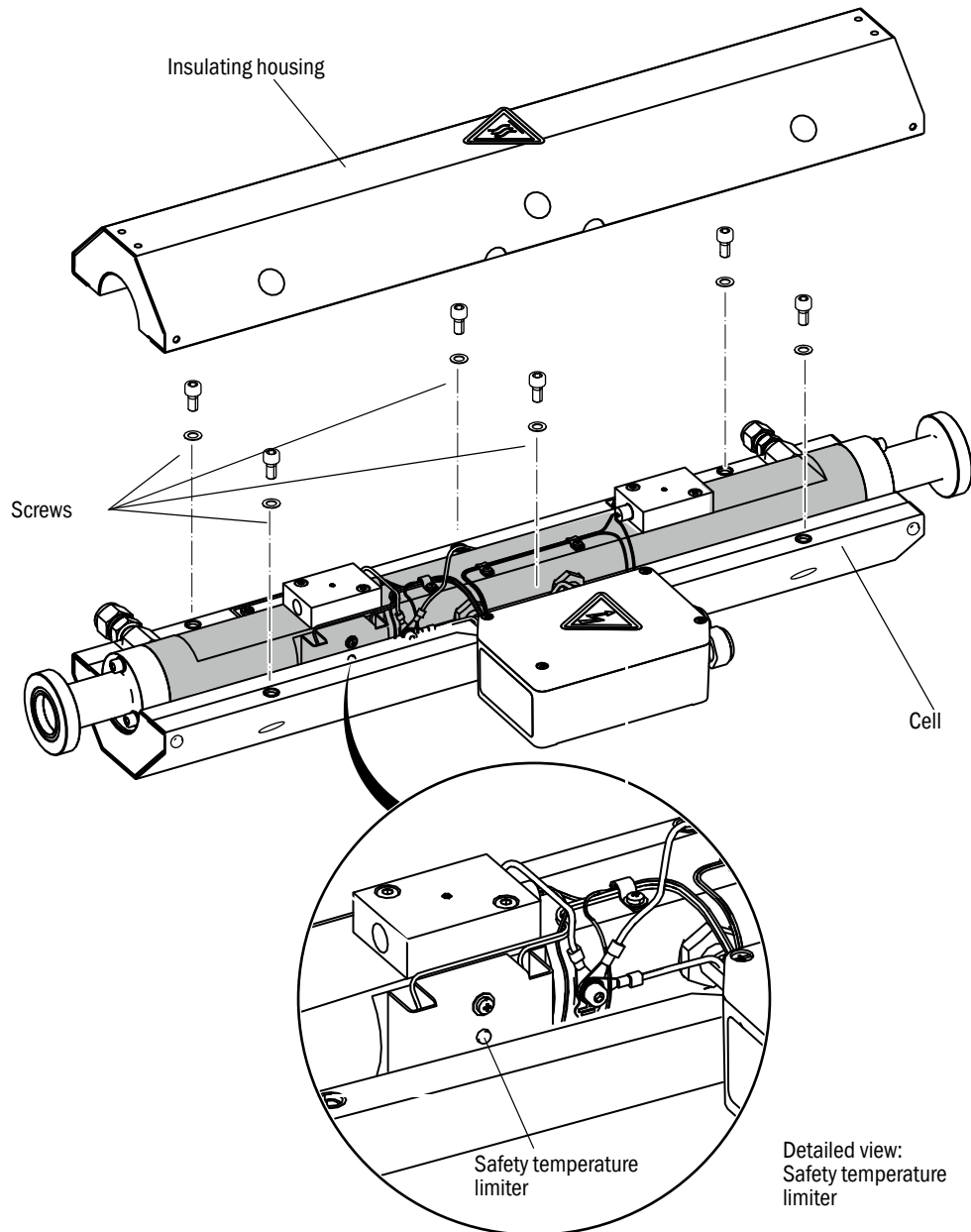
6.6.2 Installing the filter element

- ▶ Filter element, spring and two O-rings: Use new parts.
 - 1 Clean the screw-in fitting and filter housing.
 - 2 Place the O-ring (filter housing) on the filter housing.
 - 3 Screw the filter housing into the cell.
 - 4 Insert the spring into the screw-in fitting.
 - 5 Place the O-ring (screw-in fitting) into the filter housing.
 - 6 Insert the filter element into the filter housing with the opening facing the filter housing.
 - 7 Screw the screw-in fitting with spring hand-tight into the filter housing.
Ensure that the O-ring is seated correctly.
 - 8 Tighten the screw-in fitting.
To do this, hold against the filter housing.
 - 9 Reassemble the insulating housing.
[See “Installing the cell in the insulating housing.”, page 25.](#)

6.7 Removing and installing the insulating housing

6.7.1 Removing the cell from the insulating housing

Fig. 10: Removing the insulating housing



CAUTION: Safety temperature limiter
 ► Press the button when triggered.

- 1 Unscrew the screws (hexagon socket M5).
- 2 Disconnect the grounding cable if necessary.
- 3 Lift off the insulating housing.
- 4 Remove the cell.

6.7.2 Installing the cell in the insulating housing.

- 1 Fit the cell in the insulating housing ([see Fig. 10](#)).
If necessary, reconnect the grounding cable.
- 2 Screw the screws of the insulating housing tight.

7 Clearing malfunctions

7.1 Clearing malfunctions

Malfunction	Possible cause	Correction
Gas flow rate inadequate	Sample gas path blocked.	Clean.
Leak.	Sample gas path leaky.	Seal.
	Cell window leaky.	Clean or renew window.
Safety temperature limiter has triggered.	Temperature on temperature controller set too high.	Correct the temperature setpoint (see MCS300P Operating Instructions).
Heating does not work.	No voltage supply.	Provide power connection.
	Safety temperature limiter has triggered.	Reset the safety temperature switch. See "Removing the cell from the insulating housing" , page 24.
	Safety temperature limiter is defective.	Contact E+H Service.
	Pt100 defective	Contact E+H Service.
	Heating cartridge defective	Contact E+H Service.
Not enough energy at the analyzer detector.	Cell window soiled.	Clean cell. See "Installing the cell on the MCS300P gas analyzer" , page 18.
Unstable measurement signal.	Temperature difference between cell and sample gas very high.	Correct the temperature setpoint (see MCS300P Operating Instructions).
	Cell window soiled.	Check cell temperature and clean cell as necessary. See "Installing the cell on the MCS300P gas analyzer" , page 18.

7.2 Safety temperature limiter has triggered.

Switch-off temperature: Approx. 235 °C (455 °F) or for AGK75 HT approx. 245 °C (473 °F)



When the safety temperature switch has switched off the cell, it is possible that the seals of the cell are damaged.

► AGK50/75 (Standard): Replace seals.

AGK75-HT: Seal replacement is not required.

8 Technical specification

8.1 Compliance

The technical design of this device complies with the following EU directives and EN standards:

Applied EN standards:

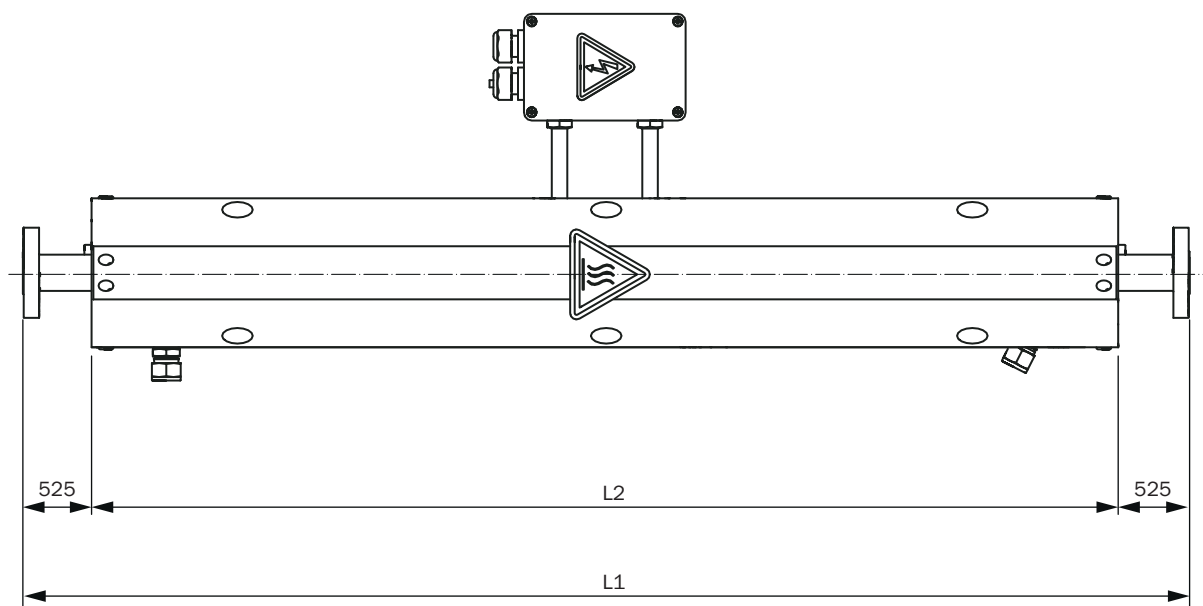
- EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use
- EN 61326, Electrical equipment for measurement technology, control technology and laboratory use - EMC requirements

8.1.1 Electrical protection

- Insulation: Protection class 1 in accordance with EN 61010-1.
- Pollution: The device operates safely in an environment up to pollution degree 2 in accordance with EN 61010-1 (normal, non-conductive pollution and temporary conductivity due to occasional condensation).

8.2 Dimensions

8.2.1 Dimensions AGK50, AGK75, AGK75 HT



Cells	L1 in mm (in)	L2 in mm (in)
AGK50: 50 cm	647 (25.47)	542 (21.34)
AGK75/AGK75 HT: 750 cm	897 (35.31)	792 (31.18)

8.3 Technical data



Refer to the Data Sheet delivered with the cell for the materials used.

Cell characteristics	
Optical path length	AGK50: 50 cm (19.69 in.) AGK75: 75 cm (29.53 in.) AGK75 HT: 75 cm (29.53 in.)
Materials with media contact: - Cell body - Window - O-rings	Stainless steel 1.4571 (SS316Ti) Quartz, CaF ₂ , BaF ₂ Isolast, Option: Viton, Kalrez
Weight	AGK50: Approx. 15 kg (33.1 lb) AGK75: Approx. 20 kg (44.1 lb) AGK75 HT: Approx. 20 kg (44.1 lb)
Sample gas volume	AGK50: Approx. 360 cm ³ (22 in ³) AGK75: Approx. 540 cm ³ (33 in ³) AGK75 HT: 540 cm ³ (33 in ³)

Ambient conditions	
Installation site	Indoor installation (inside buildings)
Installation height	up to 2,000 m above sea level
Contamination level	2
Ambient temperature (operation)	+5 ... +40 °C (+40 ... +100 °F)
Ambient temperature (storage)	-20 ... +70 °C (0 ... +160 °F)
Relative humidity	Max. 90% (without condensation)
Air pressure	850 ... 1100 hPa

Operating conditions	
Ambient temperature	+5 ... +40 °C (+40 ... +100 °F)
Storage temperature	-20 ... +70 °C (0 ... +160 °F)
Relative humidity	Max. 80%
Degree of protection	IP20
Heating temperature	<ul style="list-style-type: none"> • Max. 200 °C (390 °F) with Viton O-rings (standard) • Max. 220 °C (428 °F) mit Isolast O-rings • Max. 240 °C (464 °F) for HT cell with Kalrez O-rings
Temperature sensor	1 x Pt 100
Heating up time	From room temperature to approx. +50 °C (+120 °F): Approx. 1 h From room temperature to approx. +200 °C (+300 °F): Approx. 2 h
Operating pressure	<ul style="list-style-type: none"> - Quartz, CaF₂: Max. 20 bar (2000 kPa) absolute - BaF₂: Max. 10 bar (1000 kPa) absolute (For T = +5 °C ... +150 °C (+40 ... +300 °F))

Mechanical installation	
Fitting position	Any
Piping	Pipe screw fitting for pipe outer diameter: AGK50: 6 mm (standard) for AGK75/75-HT: 6 mm, 8 mm, 10 mm, 12 mm, 1/4"

Sample gas (requirements)	
Temperature	Thermostatically controlled to cell temperature Max. temperature: 200 °C (392 °F)
Flow rate	30 ... 1000 l/h (1 ... 35 ft ³ /h)
Cleanness	Free from dust and condensed components

Electrical installation	
Input voltage	115 or 230 V +10% / -15%; 50...60 Hz
Power input	AGK50: Max. 275 VA AGK75: Max. 550 VA
Electrical connection cables: - Power supply - Pt100	3 x AWG 18 2 or 4 * AWG 20

8.3.1 Cable glands

Connection	Type	Size	Clamping range mm	Tightening torque Nm
Heater	Plastic	M16	5 ... 10	3
Pt100				

8.3.2 Connection terminals

Input voltage, Pt100

Conductor	Cross-section in mm ²	Cross-section in AWG	Tightening torque Nm
Rigid	0,2...2,5	24...14	0,5...0,6
Flexible with ferrules	0,25...1,5	24...16	
Flexible with ferrules with insulating collar	0,25...1,0	24...18	

8.3.3 Torques

Tighten all screw connections, for which no tightening torque or no pretension force is specified in drawings or Mounting Instructions, according to VDI 2230.

All connections with screws which are not classic screw connections are excluded from this rule. This means strap retainers, cable glands, screw fittings, gas connections, screws for circuit boards etc. Here, the screw fittings have to be tightened as evenly as possible with a significantly lower tightening torque (strap retainers 1 Nm, other screw fittings according to manufacturer specification).

Select the next lowest torque valid for the screw for mixed materials and special screws such as relieved screws.

The basic friction coefficient is (screw fittings without lubrication) $\mu_k = \mu_G = 0.14$. The calculated values are valid for room temperature ($T = 20\text{ °C} / 80\text{ °F}$).

Table 1: Torques

Dimension M	Pitch P	Tightening torque Ma (Nm)					
		3.6	4.6	5.6	8.8, A2 and A4-80	10.9	12.9
1.6	0.4	0.05		0.05	0.17		0.28
2	0.45	0.1		0.11	0.35		0.6
2.5	0.45	0.21		0.23	0.73		1.23
3	0.5		0.54	1	1.3	1.7	2
3.5	0.6		0.85	1.3	1.9	2.6	3.2
4	0.7		1.02	2	2.5	4.4	5.1
5	0.8		2	2.7	5	8.7	10
6	1		3.5	4.6	10	15	18
8	1.25		8.4	11	25	36	43
10	1.5		17	22	49	72	84
12	1.75		29	39	85	125	145
14	2		46	62	135	200	235
16	2		71	95	210	310	365
18	2.5		97	130	300	430	500
20	2.5		138	184	425	610	710
22	2.5		186	250	580	830	970
24	3		235	315	730	1050	1220
27	3		350	470	1100	1550	1800
30	3.5		475	635	1450	2100	2450
33	3.5		645	865	2000	2800	3400
36	4		1080	1440	2600	3700	4300
39	4		1330	1780	3400	4800	5600

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