OPERATING INSTRUCTIONS

S700 Series

Extractive Gas Analyzers

Installation · Operation · Maintenance

SICK
Sensor Intelligence.

Described product

Product name:	S700
Versions:	S710 S710 CSA S711 S711 CSA S715 standard S715 CSA S715 EX S715 EX CSA S720 Ex S721 Ex
Firmware:	As from 1.6

The special functions for the water analyzers of the TOCOR Series are not described in this document.

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Original document
This document is an original document of SICK AG.

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Contents

1 About this document

1.1 Symbols and document conventions

1.1.1 Warning symbols

Symbol	Meaning
	Hazard (general)
	Hazard by voltage
	Hazard in potentially explosive atmospheres
	Hazard by explosive substances/mixtures
	Hazard by toxic substances
	Hazard by acidic substances
	Hazard for the environment/nature/organic life

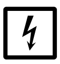
1.1.2 Warning levels and signal words

WARNING:
Risk or hazardous situation which *could* result in severe personal injury or death.

CAUTION:
Hazard or unsafe practice which *could* result in less severe or minor injuries.

NOTE:
Hazard which *could* result in property damage.

1.1.3 Information symbols

Symbol	Meaning
	Information on product characteristics with regard to protection against explosions
	Important technical information for this product
	Important information on electrical or electronic functions

1.2 Additional documents

Separately supplied document:

- Declaration of Conformity

Additional documents, if applicable:

- CSA Certificate of Compliance
- Statement of Conformity on use in potentially explosive atmospheres
- EC Type Examination Certificate

NOTE:
- Observe the supplied documents.
- Pay primary attention to any individual information provided.

Many specifications of the certification documents are considered in this document. However:
- For legal and official consequences, refer to the original certificates.

2 Safety instructions

2.1 Primary safety notes

Dangerous sample gases


WARNING: Hazards by dangerous sample gases

- *If the sample gas can be dangerous to health:* Escaping sample gas can be an acute danger for persons.
- *If the sample gas is combustible:* If sample gas escapes during a defect, a combustible gas mixture can be created with the ambient air. Thus, there can be a risk of explosion.

▶ Carefully observe the safety information and application limitations on the sample gases.

Otherwise operation is not safe.

• General measures for health protection	see “Responsibility of user”, page 17
• Application limitations of the S700 versions	see “Application limitations (overview)”, page 16
• Safety information on installation	see “Safety measures against dangerous gases”, page 33
• Safety when opening the enclosure	see “Safety precautions before opening the enclosure”, page 44
• Safety during maintenance and repair work	see “Safety information on disassembly of components”, page 173

Potentially explosive atmospheres

WARNING: Hazards in potentially explosive atmospheres

When the S700 is to be used in a potentially explosive atmosphere:

▶ Carefully observe the applicable safety information in this document.

Otherwise operation is not safe.

• Usage options in potentially explosive atmospheres	see “Characteristics of the enclosure types”, page 19
• Safety information on installation in potentially explosive atmospheres	see “Safety in potentially explosive atmospheres”, page 33
• Safety when opening the enclosure	see “Safety precautions before opening the enclosure”, page 44
• Intact state of the connection cables	see “Visual check”, page 175

2.2 Basic operating notes

Start-up

▶ Ensure gas-tightness; check the filters, valves etc.,	see “Leak tightness check of sample gas path”, page 176
▶ Prevent condensation in the sample gas path of the gas analyzer,	see “General safety information on installation”, page 34
▶ Perform a calibration after each start-up,	see “Calibration”, page 123
▶ Observe the information on special calibrations,	see “Special calibrations”, page 144
– *Additionally in potentially explosive atmospheres:*	
▶ Make sure the enclosure is tightly closed,	see “Closing the enclosure”, page 46
S715 EX/S715 EX CSA – if the enclosure was opened: ▶ Perform a leak test.	see “Leak tightness check for the enclosure S715 EX”, page 178

Operating state

▶ Observe the LEDs:	
– “Function” green = normal state – “Function” RED = malfunction – “Service” YELLOW = need for action,	see “LEDs”, page 68
– “Alarm” RED = at least one measured value is beyond a limit value,	see “Setting alarm limit values”, page 91
▶ Observe the status messages on the display,	see “Main Menu”, page 73
▶ Perform calibrations at regular intervals,	see “Guideline for calibrations”, page 125

When “Alarm” is indicated

- ▶ Check the current measured values. Consider the situation.
- ▶ Perform the measures specified at your site for this situation.
- ▶ If necessary: Switch the alarm signal off (see “Acknowledging alarms”, page 82).

In hazardous situations

- ▶ Switch-off the system’s emergency switch or mains switch.

+i The main power switch of the S710/S711 is located on the rear of the enclosure next to the power plug (see Fig. 7, page 51).

Shutdown procedure

- ▶ *Before shutting down:* Purge the sample gas path with a dry neutral gas to prevent condensation in the measuring system (see “Shutdown procedure”, page 191).

2.3 Intended use

2.3.1 Designated users (target group)

All tasks and measures described in this document should be carried out by *skilled persons* who are *trained* and *qualified* to do the following jobs – in skillful quality and with respect to the intended use:

- mechanical installation
- electrical installation
- device configuration and adaptation
- handling and supervision during operation
- maintenance

Moreover, these skilled persons should be familiar with the potential *risks* and *hazards* which might usually occur even if the tasks and measures are carried out skillfully. They should know and follow all the related *safety precautions*.

> This Manual is an important part of the device. Please store this Manual in a safe place after use.

2.3.2 Designated range of application

Measuring function

Gas analyzers of the S700 series measure the concentration of a particular gas in a gas mixture (sample gas). The sample gas flows through the internal measuring system of the gas analyzer. If the S700 is equipped with more than one analyzer module and/or with a MULTOR or FINOR analyzer module, then the concentration of more than one gas component can be measured simultaneously.

Areas of usage

- *Indoor use:* Gas analyzers of the S700 series are designated for indoor use. Direct influence of the atmospheric weather (wind, rain, sun) could damage the device and can have a severe effect on measuring precision.
- *Application limitations:* The area of usage is limited depending on the enclosure type (see “Characteristics of the enclosure types”, page 19).

WARNING: Risk of explosion - health risks

- ▶ Observe the stated application limitations (see “Characteristics of the enclosure types”, page 19).
- ▶ Observe the general measures on health protection (see “Responsibility of user”, page 17).

2.4 Application limitations (overview)

WARNING: Risk of explosion - health risks

- ▸ Observe the stated application limitations (see “Characteristics of the enclosure types”, page 19).
- ▸ Observe the general measures on health protection (see “Responsibility of user”, page 17).

Use in potentially explosive atmospheres

The usage options in potentially explosive atmospheres depend on the enclosure type (see “Characteristics of the enclosure types”, page 19).

Application limitations for explosive/combustible sample gases

- Do not use the S700 for measuring explosive gases or gas mixtures.
- The usage options for measuring combustible gases depend on the enclosure type and certain conditions (see “Characteristics of the enclosure types”, page 19).

Chemical application limitations

NOTE: Risk of damage

Chemically aggressive gases can damage the measuring system of the gas analyzer. This can make the gas analyzer unusable.

- ▸ Prior to operation, check if the materials of the measuring system could have been damaged by the sample gas (see “Materials in contact with the sample gas”, page 218).

Physical application limitations

In some applications, certain gas components could interfere with the analysis – for example, because a similar measuring effect is produced and this effect can not be eliminated, due to the laws of nature or technical limitations. A consequence could be that the measured values would shift when the composition of the sample gas has changed, even if the concentration of the measured gas components is still the same.

- ▸ *In such cases:* whenever the sample gas composition has changed, perform a new calibration using new test gases which correspond to the new sample gas composition.
- ▸ This might not be necessary if your S700 has an automatic compensation for such effects (see “Cross-sensitivity and gas matrix effect compensation”, page 26). For the relevant information, see the delivered documents; in case of doubt, ask the manufacturer.

2.5 Responsibility of user

intended users

The gas analyzer S700 should only be operated by skilled persons who, based on their technical training and knowledge as well as knowledge of the relevant regulations, can assess the tasks given and recognize the dangers involved.

Correct use

- Use and operate the device only as it is described and specified in these Operating Instructions. The manufacturer is not responsible for any other use.
- Carry out the specified maintenance tasks.
- Do not remove, add, or change any component in the device unless such changes are officially allowed and specified by the manufacturer. Otherwise
  - the device might become dangerous
  - the manufacturer's guarantee becomes invalid
  - The Type Examination Certificate becomes invalid (only for the ATEX version)

WARNING: Risk through incorrect use
Equipment-internal protection devices can be impaired when the device is not used as defined.
- Read this Operating Instructions before installation, start-up, operation and maintenance and observe all information on using the device.

Special local requirements

- In addition to these Operating Instructions, observe all local laws, technical rules, and company-internal instructions valid at the site where your S700 is used.

Health protection

WARNING: Health risks through sample gas
If the sample gas can be dangerous to health:
Escaping sample gas can be an acute danger for persons. The concept of the measuring system must contain the relevant safety measures for health protection. [1]
- *During installation:* Ensure that the safety information on installation is observed (see "Safety information on installation", page 33).
- *After installation/during operation:*
  - Ensure that all persons involved are informed on the sample gas composition as well as know and adhere to the relevant safety measures concerning health protection.
  - *If the leak tightness of the gas paths is questionable:* Perform a leak tightness check (see "Leak tightness check of sample gas path", page 176).

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[1] The operating company is responsible for the composition of sample gas and the relevant safety measures.

Preserving the documents

- Keep the Operating Instructions available for consulting.
- Pass the Operating Instructions on to a new owner.

3 Product description

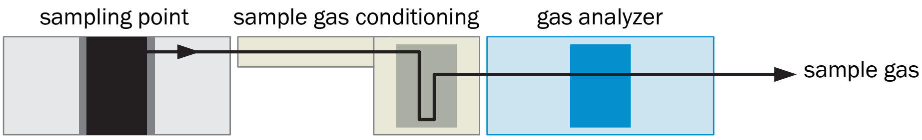
3.1 Application principle

S700 is an extractive gas analyzer with continuous measuring operation:

- *Extractive gas analysis* means that a certain portion of the gas which is to be analyzed is extracted from the total quantity of the gas (“sample gas” from the “sampling point”) and is then passed to the gas analyzer.
- *Continuous measurement* means that a continuous sample gas flow to the gas analyzer is maintained, and that the gas analyzer is continuously delivering current measured values.
- For most applications, a *sample gas conditioning* is required. Depending on the individual application, suitable devices can be:

Particle filters	Protect the measuring system of the gas analyzer from contamination
Heated sample gas lines	Prevent condensation or ice blockages in the sample gas path
Liquid separators	Remove liquids or condensable components from the sample gas
Safety devices	Protect the gas analyzer and the peripheral system against each other (e.g. flame arresters in the gas path)

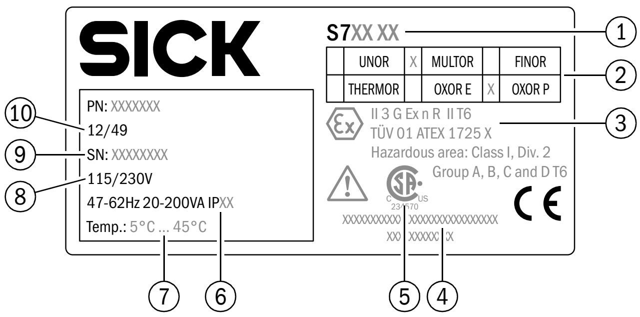
Fig. 1: Extractive gas analysis



- Projection notes on extractive sample gas feed, see “Designing the sample gas feed”, page 37
- Operating conditions for the sample gas feed, see “Connecting the sample gas inlet (SAMPLE)”, page 41

3.2 Product identification

Fig. 2: Type plate (schematic)



1	Product name
2	Fitted analyzer modules
3	Explosion protection specification (see “Enclosure specifications”, page 213)
4	Manufacturer
5	Identification of CSA versions (see “CSA versions”, page 22)
6	IP degree of protection of enclosure
7	Permissible ambient temperature during operation
8	Power voltages (see “Power connection”, page 49)
9	Serial number
10	Date of manufacture (year/week)

3.3 Characteristics of the enclosure types

WARNING: Risk of explosion - health risks
- ▶ Observe the application limitations of the enclosure types.
- ▶ Observe the general measures on health protection (see "Responsibility of user", page 17).

3.3.1 S710/S711 · S710 CSA/S711 CSA

Design

- 19" plug-in unit for mounting in standard 19" racks or corresponding outer housing.
- S711: Smaller mounting depth, limited set of equipment options.

- Dimensions, see Fig. 30, page 211.
- Special characteristics of CSA versions, see "CSA versions", page 22.

Application limitations for enclosure type, S710/S711, S710 CSA/S711 CSA

- Do not use in potentially explosive atmospheres.
- Do not feed explosive gases or gas mixtures.
- Only use for measurement of combustible gases or gas mixtures when the "Conditions for combustible sample gases" are fulfilled (see below).

Conditions for combustible sample gases

Possible gas concentrations in the sample gas	Consequence for S710/S711/S710 CSA/S711 CSA
≤ 25 % of the lower explosion limit	Measurement is allowed without any further measures.
> 25 % of the lower explosion limit [1]	Measurement is allowed when the following conditions are maintained: ▶ Ensure an unhindered air exchange between enclosure and the environment. *Further measures:* ▶ Ensure that the sample gas pressure can not exceed the allowable sample gas pressure (see "Gas technical requirements", page 216). ▶ Regularly check the leak tightness of the sample gas path. ▶ *Recommendations for device versions with sample gas paths with hoses (especially "Viton"):* Check the material consistency of the hoses every 3 years. Replace the hoses if necessary.

[1] And always below the lower explosion limit.

WARNING: Risk of explosion
- ▶ Observe and adhere to the application limitations.

Otherwise operation is not safe and there is a risk of explosion.

3.3.2 S715 standard · S715 CSA

Design

- Closed field enclosure for wall mounting in industrial environment.
- *Upper section:* Electronics, electrical connections.
- *Lower section:* Analyzer modules.
- *Option:* Purge gas connections.

- Dimensions, see Fig. 31, page 211.
- Special characteristics of CSA versions, see “CSA versions”, page 22.

Application limitations for enclosure type, S715 standard/S715 CSA, /

- Do not use in potentially explosive atmospheres.
- Do not feed explosive gases or gas mixtures.
- Only use for measurement of combustible gases or gas mixtures when the “Conditions for combustible sample gases” are fulfilled (see below).

Conditions for combustible sample gases

Possible gas concentrations in the sample gas	Consequence for S715 standard/S715 CSA
≤ 25 % of the lower explosion limit	The measurement is allowed without any further measures.
> 25 % of the lower explosion limit [1]	The measurement is allowed when the following conditions are maintained: ▶ Purge the enclosure with inert gas (e.g. with nitrogen). Monitor the purge gas flow rate (10 ... 30 l/h at the purge gas outlet). *Further measures*: ▶ Ensure that the sample gas pressure can not exceed the allowable sample gas pressure (see “Gas technical requirements”, page 216). ▶ Regularly check the leak tightness of the sample gas path. ▶ *Recommendations for device versions with sample gas paths with hoses (especially “Viton”):* Check the material consistency of the gas hoses every 3 years. Replace the gas hoses if necessary.

[1] And always below the lower explosion limit.

WARNING: Risk of explosion
▶ Observe and adhere to the application limitations.
Otherwise operation is not safe and there is a risk of explosion.

3.3.3 S715 EX · S715 EX CSA

Design

- As S715 standard/S715 CSA, however:
  - Vapor-proof enclosure (degree of protection “nr”) for use in potentially explosive atmospheres of zone 2.
  - internal gas paths tube-connected.
  - Gas connection for leak tightness check of the enclosure.
- *Option:* Purge gas connections.

> - Dimensions, see Fig. 31, page 211.
> - Special characteristics of CSA versions, see “CSA versions”, page 22.
> - Identification of explosion protection, see “Enclosure specifications”, page 213.

ATEX certification for potentially explosive atmospheres (zone 2)

The ATEX certification for gas analyzers of typeS715 EX consists of the following documents:

- Statement of Conformity TÜV 01 ATEX 1725 X
- 3rd Supplement to Statement of Conformity TÜV 01 ATEX 1725 X.

> The “1st Supplement to Statement of Conformity TÜV 01 ATEX 1725 X” and the “2nd Supplement to Statement of Conformity TÜV 01 ATEX 1725 X” apply for S715 versions which are no longer produced.

Application conditions for enclosure types S715 EX/S715 EX CSA

- Only use in potentially explosive atmospheres (zone 2) when the Declaration of Conformity allows it and when the “special conditions” of the Declaration of Conformity are fulfilled.
- Do not feed explosive gases or gas mixtures.
- Only use for combustible gases or gas mixtures when the “Conditions for combustible sample gases” are fulfilled (see below).
- Check the leak tightness of the enclosure after each closing of the enclosure/prior to start-up (see “Leak tightness check for the enclosure S715 EX”, page 178).

Conditions for combustible sample gases

- Only use a gas analyzer type S715 EX/S715 EX CSA in potentially explosive atmospheres when one of the following conditions is met: [1]
  - The sample gas is not combustible.

  Or:
  - The concentration of the sample gases is always at max. 25 % of the lower explosion limit.

WARNING: Risk of explosion
▶ Carefully observe and adhere to the application conditions.
Otherwise operation is not safe and there is a risk of explosion.

[1] Specifications of the Declaration of Conformity.

3.3.4 S720 Ex/S721 Ex

Design

- Massive enclosure for use in potentially explosive atmospheres (Exd).
- Flame arresters in the sample gas connections.
- Three-part enclosure:
  - Analyzer enclosure (analyzer modules, electronics, electrical connections).
  - Satellites: Keypad, display enclosure (permanently connected via cable).
- *S720 Ex:* Smaller analyzer enclosure, limited set of equipment options.

> - Dimensions, see Fig. 32, page 212.
> - Identification of explosion protection, see "Enclosure specifications", page 213.

EC Type Examination Certificate for potentially explosive atmospheres

The certification for the gas analyzers type S720 Ex/S721 Ex consists of the "EC Type Examination Certificate TÜV 97 ATEX 1207 X" for gas analyzers of the 620 Ex series and several "Supplements".

> The certification for potentially explosive atmospheres was made as a supplement of the existing certification for 620 Ex series gas analyzers.
> The numbers of the terminal connection stated in the EC Type Examination Certificate, page 1 to 4, only apply for gas analyzers of the 620 Ex series and do not apply for enclosure types S720 Ex/S721 Ex.

Application conditions for enclosure type S720 Ex/S721 Ex

- Only use in potentially explosive atmospheres when the EC Type Examination Certificate allows it and when the "special conditions" of the EC Type Examination Certificate are fulfilled.
- Ensure that the sample gas pressure can not be greater than 10 kPa (100 mbar).[1]
- Observe all relevant laws, standards and regulations which are valid at the installation location (e.g. EN 60079-14).
- *If the sample gas is combustible:* Use a device version with sample gas paths with hoses (internal gas paths made of metal tubing).
- *Recommendation:* Let the installation be made by specially trained and authorized skilled persons.

WARNING: Risk of explosion
- ▶ Carefully observe and adhere to the application conditions.

Otherwise operation is not safe and there is a risk of explosion.

3.3.5 CSA versions

- CSA versions are for use in the validity range of the CSA.
- For CSA versions, special specifications apply for:
  - Switching outputs (see "Maximum load of the signal connections", page 55)
  - Power connection (see "Electrical specifications", page 215).

> Identification of CSA versions, see "Product identification", page 18.

[1] Further information, see Declaration of Conformity.

3.4 Know-how for the S700

3.4.1 Special features

• Several analyzer modules: A S700 can contain up to three analyzer modules.	see "Analyzer modules", page 24
• *Multi-component measurement:* The S700 measures all measuring components simultaneously every 0.5 ... 20 seconds. [1]	see "Combined display for all components", page 74
• *Cross-sensitivity compensation:* Common measuring influences of the individual gas components can be compensated.	see "Cross-sensitivity and gas matrix effect compensation", page 26
• *Calibration cuvette:* This option can speed-up routine calibrations of UNOR and MULTOR analyzer modules and reduce test gas consumption.	see "Calibration cuvette for analyzer modules UNOR and MULTOR", page 24
• Configurable signal connections: The S700 has 8 control inputs and 13 switching outputs, with freely assignable functions.	see "Available control functions", page 99 / "Available switching functions", page 98
• *Configurable measured value outputs:* The S700 has 4 analog measured value outputs (0/2/4 ... 20 mA). – You can select which measured value output is used for a certain measuring component. One measured value can also be output on several measured value outputs. – Each measured value output has 2 output ranges. The output ranges are adjustable.	 see "Assigning measuring components", page 93 see "Setting-up the output ranges", page 94
• *Digital data output:* The S700 can also transmit the measured values and status messages via a serial RS232 interface.	see "Function of the interfaces", page 65
• *Chart recorder simulation:* The S700 can display a continuous image of previous measured values.	see "Chart recorder simulation", page 75
• *Integration of external measured values:* Measuring signals of other devices can be fed and shown the same as internal measuring components	see "Analog inputs", page 58
• *2 zero gases:* For zero point calibration, the nominal values for two different "zero gases" can be set. This allows you to calibrate different analyzer modules which require individual zero gases. Cross-sensitivity effects can be compensated with negative nominal values.	see "Cross-sensitivity compensation with OXOR-P", page 156
• *4 test gases:* For sensitivity calibration, nominal values for four different test gases can be set. Which measuring component is calibrated with which test gas is selectable. Test gas mixtures for the calibration of several measuring components are possible.	see "Test gases for sensitivity calibration", page 127
• *Data storage:* – The S700 can save copies of the current settings and data, and reactivate theses via menu command. – The data of the S700 can be saved on a computer and restored.	 see "Using an internal backup", page 109 see "Using an external backup", page 110
• *Remote control:* The S700 can be controlled via a digital remote control. – With "AK protocol" commands. – Via "Modbus" interface.	 see "Remote control with "AK protocol"", page 159 see "Remote control with Modbus", page 165
• *Firmware update:* The internal software of the S700 can be updated via interface.	see "Firmware update", page 113

[1] Depending on the number of measuring components and physical measuring range.

3.4.2 Analyzer modules

Depending on its configuration, the S700 can measure up to five gas components simultaneously. For this purpose, up to three different analyzer modules (physical measuring systems) can be installed.

An analyzer module contains the physical analysis unit and basic electronic circuits. The different analyzer module types use individual measuring principles and therefore have specific physical characteristics.

The analyzer module fitted in the device is noted on the type plate and can be shown on the display (see “Display of device data”, page 79).

Table 1: Analyzer modules for the S700

Analyzer module	Measuring principle	Measuring components, application
FINOR	NDIR [1]	CO, CO_2, CH_4, SF_6 (1 ... 3 meas. components)
MULTOR	NDIR [2]	2 ... 4 NDIR measuring components
UNOR	NDIR [2]	1 NDIR measuring component
OXOR-P	Paramagnetism	O_2, high requirements (see “Analyzer modules for 02 measurement”, page 25)
OXOR-E	Electrochemical cell	O_2, standard requirements (see “Analyzer modules for 02 measurement”, page 25)
THERMOR	Thermal conductivity	H_2, CO_2, He and others
THERMOR 3K	Thermal conductivity	special H_2/CO_2 application (see “Special version “THERMOR 3K””, page 194)

[1] Non-dispersive infrared absorption (optical cuvette; solid-state detector).
[2] Non-dispersive infrared absorption (optical cuvette; selective pneumatic detector).

See separate data sheet for characteristics and possible combinations of the analyzer modules.

3.4.3 Calibration cuvette for analyzer modules UNOR and MULTOR

The option “calibration cuvette” allows you to perform routine sensitivity calibrations for the analyzer modules UNOR and MULTOR without using special test gases – only a “zero gas” is required.

A calibration cuvette contains a test gas mixture for the sensitivity calibration and can be rotated into the optical path of the analyzer module.

During the calibration, zero gas flows permanently through the analyzer module. The first step is a zero point calibration. When the sensitivity calibration starts, the calibration cuvette is automatically moved into the optical path, and the test gas mixture in the calibration cuvette simulates the presence of a test gas in the measuring cuvette.

The nominal values of this simulation are first determined and programmed at the factory. During operation, these nominal values only have to be checked and adjusted from time to time (recommendation: every 6 months; procedure, see “Calibration of the calibration cuvette (option)”, page 150).

3.4.4 Analyzer modules for O_2 measurement

OXOR-E (electrochemical cell)

The OXOR-E module has an electrochemical O_2 sensor which is filled with an electrolyte. A PTFE membrane is used to let O_2 molecules diffuse into the sensor. The O_2 molecules are chemically transformed on a metal electrode. This chemical reaction produces an electric current which is measured.

Because the chemical reaction consumes the electrolyte, the O_2 sensor needs to be replaced after a certain period of use. Moreover, the sensor life may be reduced by disadvantageous sample gas mixtures – for example, by aerosols and high SO_2 concentrations (see “Replacing the O2 sensor in the OXOR-E module”, page 180).

OXOR-P (paramagnetic measuring cell)

The OXOR-P analyzer module contains a diamagnetic dumbbell which is suspended in a magnetic field in such a way that it could rotate out of this field. An opto-electrical compensation circuit is used to keep the dumbbell in a defined resting position.

The sample gas flows through the measuring cell. If the sample gas contains O_2, the paramagnetic characteristic of O_2 will change the magnetic field. This causes an adaptation of the opto-electronic compensation, which is read by the software and evaluated as an O_2 concentration change.

The selectivity of the OXOR-P module is based on the extremely high magnetic susceptibility of oxygen. The magnetic characteristics of other gases are so small in the relation that they do not need to be considered, usually. However, if there are sample gas components which also have a relatively high magnetic susceptibility, then measurement errors might occur. There are several methods to compensate for this error effect (see “Cross-sensitivity compensation with OXOR-P”, page 156).

3.4.5 Cross-sensitivity and gas matrix effect compensation

Physical interferences

It is possible that a particular sample gas component disturbs the analysis of another measuring component – by producing a similar measuring effect or by physically interfering with the analysis. There are applications where this effect cannot be avoided, due to the laws of nature or due to technical limitations. In such cases, the gas analyzer would not only respond to the specific measuring components, but also to the interfering gas component. As a result, the measured values would be incorrect.

Two technical expressions are used to describe the possible physical effects:

"Cross-sensitivity"

A cross-sensitivity occurs when the interfering gas component produces an additional measuring effect. The main characteristic of a cross-sensitivity is that the analyzer still displays a measured value even when the measuring component is not present in the sample gas (interfering effect at zero point). A constant concentration of the interfering component will produce a constant "offset" all over the measuring range. When the interfering concentration changes, the offset will change accordingly.

"Carrier gas effect"

A carrier gas effect interferes with the required analysis effect. The result is that the measuring sensitivity is changed by the presence of the interfering gas component. The main characteristic is that the misreading increases for higher measured values. As for the cross-sensitivity, the interfering effect follows the current concentration of the interfering component.

Compensation

To compensate for such effects, the following options are available:

- *Internal cross-sensitivity compensation:* For this option, the S700 must also measure the concentration of the interfering gas component. A basic calibration is performed at the factory where S700 "learns" how these two measurements influence each other. Thereafter the S700 software can compensate for the interfering effect and will produce technically corrected measured values. In addition, the S700 can consider if the cross-sensitivity effect also occurs during a calibration or not (see "Calibration of cross-sensitivity compensations (option)", page 154).
- *External cross-sensitivity compensation:* The S700 has to be fed with an analog measuring signal, which represents the current concentration of the interfering gas component (see "Analog inputs", page 58). This method can also be used against other interfering effects. Because of the various application options, this option normally requires an individual adaptation of the S700 software.
- *Carrier gas compensation:* As for the internal cross-sensitivity compensation, the S700 additionally has to measure the concentration of the interfering gas component and "learn" during a basic calibration at the factory how to compensate the interfering effect. – Consider for calibrations that only the test gas used for calibrating the sensitivity of "interfering components" may contain the interfering gas components; all other calibration gases must not contain the interfering components, otherwise the calibration becomes faulty.

- If your S700 is working with an automatic compensation, please observe the information in see "Automatic compensations", page 196.
- To find out whether your S700 is working with one of these options, see "Information on active compensations", page 196.

3.5 Optional equipment

Some usage options depend on whether your S700 is equipped with a particular option (see following Tables). Please observe the individual order and delivery information for your device.

Table 2: Hardware options

Option	Effect	possible in
Built-in gas pump	Delivers a gas flow (for example, sample gas). The pump capacity can be adjusted via menu function (see “Setting the capacity of the gas pump”, page 114).	S700
Condensate sensor	Protection of the gas analyzer: The electrical conductivity of a liquid in the gas path generates an error message and automatically shuts down the gas pump.	
Flow sensor	Monitoring of the gas flow: Generates an error message when the gas flow is lower than the set limit value (see “Setting the flow monitor set point”, page 114).	
Atmospheric pressure sensor	Compensation of the gas pressure: The measured pressure value is used to compensate the physical influence of the pressure.	
Sample gas pressure sensor		
2 separate gas paths 3 separate gas paths	Analysis of two independent sample gases; mathematical linking of the measured values is possible.	
	Reference measurement: The second sample gas serves as physical span gas in the analyzer module.	S700 with UNOR / THERMOR
Calibration cuvette	Sensitivity calibration of UNOR/MULTOR without the need of test gases (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 24).	S700 with UNOR / MULTOR
Intrinsically-safe measured value outputs	Increased electrical safety in potentially explosive atmospheres (see “Intrinsically-safe measured value outputs”, page 63).	S715 S720 Ex S721 Ex
Purge gas connections	Explosion or health protection: Purging of the enclosure with a neutral gas (see “Purge gas connections (option)”, page 43).	

Table 3: Software options

Option	possible in
Second output range for each measured value output	S700
Range ratio between two output ranges is larger than 1:5 or 1:10	
Remote control functions related to the “AK protocol” standard of the German automobile industry (see “Remote control with “AK protocol””, page 159)	
Remote control functions using “Modbus” commands (see “Remote control with Modbus”, page 165)	
Sampling point selector functions (see “Sampling point selector (option)”, page 119)	
Showing external analog measured values as an internal measuring component (see “Analog inputs”, page 58)	
Computation of measured values from an external analog signal (see “Analog inputs”, page 58), including calibration and display as an internal measuring component	
External cross-sensitivity compensation using a fed analog measured value (see “Cross-sensitivity and gas matrix effect compensation”, page 26)	
Internal cross-sensitivity compensation (see “Cross-sensitivity and gas matrix effect compensation”, page 26)	S700 with multiple analyzer modules and/or MULTOR

3.6 User Guide for the S700

3.6.1 What must you do?

To measure with the S700, the following tasks must be carried out:

Install the S700

Prepare for operation

Perform routine maintenance on the S700

In general:

+i→ Please observe the special information on the “THERMOR 3K” analyzer module (see “Special version “THERMOR 3K””, page 194).

3.6.2 What can you do in addition?

The following S700 functions can be used and adapted as required:

3.6.3 If you first wish to learn about the operating functions ...

... you can do the following:

Provisionally start-up the S700

1 First, do not install the S700 at the planned location but bring it to a place which is comfortable to work in, for example your office. Leave the S700 gas connections closed until final installation is complete.
2 Connect the mains power (see “Power connection”, page 49).
3 Start-up the S700 (see “Switch-on procedure”, page 66).

Familiarize yourself with the operating controls

Please read the introduction to the operating principle (see “Principle of operation”, page 70). Have a look at the menu system. You won’t do anything wrong if you pay attention to the following:

- Storing a new value requires to press the [Enter] key. Therefore, do not press [Enter], but [Esc] to leave the particular menu. In this way, the status will remain unchanged.
- If you have started a test calibration and you are prompted to `Save: Enter,` do not press [Enter] but [Esc] instead, because the calibration should not be changed under provisional conditions.

If the S700 is equipped with a built-in sample gas pump and you switch on the pump to check its function, please switch it off after a few seconds. It is not recommended to operate the pump when the gas paths are closed.

4 Installation

4.1 Scope of delivery

Unpack and check

1 Open the transport container.
2 Remove the protective packing.
3 Please remove the components carefully out of the case.
4 Check if all required parts have been delivered with your device ((see Table 4).

> To protect the internal gas path, the gas connections are closed with plugs. Please do not remove these plugs until you connect the gas lines.

Table 4: Scope of delivery

Analyzer	Scope of delivery
All S700	Gas analyzer, complete
	Plug-in connectors with cable terminals, each can be mechanically coded [1]
	Operating Instructions
S710 S710 CSA S711 S711 CSA	Power cable, 2 m long
S715 standard S715 CSA S715 EX S715 EX CSA	Bulkhead fittings for the gas connections [2]
	Sealing caps for closing unused cable gland bores
	Allen key SW4 for front screws
	Declaration of Conformity (only S715 EX/S715 EX CSA)
S720 Ex S721 Ex	Aids to open the analyzer enclosure [3]
	Ferrite rings [4]
	Cable straps to fix the ferrite rings [4]
	Wire-netting straps [4]
	Hose clamps to fasten the wire netting straps [4]
	EC Type Examination Certificate

[1] Standard: 6 pieces; adjusted delivery configuration: 3 pieces. Usage, see “Type of terminal connections”, page 54.
[2] Number and layout depending on the individual device version.
[3] Application, see “Opening the enclosure”, page 45.
[4] One for each cable inlet. Application, see “Correct installation of signal cables”, page 48.

4.2 Safety notes on transport

4.2.1 General safety information on lifting and carrying

CAUTION: Risk of injury through incorrect lifting and carrying the device
Injuries can occur due to the weight and protruding enclosure parts when the device tips over or drops. To prevent accidents:
- Do not use protruding parts on the enclosure to carry the device (exceptions: wall fixture, carrying grips).
- Never lift the device using the open device door.
- Consider the device weight before lifting.
- Observe the regulations for protective clothing (e.g., safety shoes, non-slip gloves)
- Grip underneath the device when possible to carry it safely.
- Use a hoist or transport equipment as an option.
- Call in further personnel as assistants as required.
- Before transporting, ensure obstacles that could cause falls or collisions are cleared away.
- Secure the device during transport.

4.2.2 Special safety information on the enclosures

S710/S711

CAUTION: Risk of injuries
The enclosure has sharp edges.
- When lifting or carrying the device , take care that you won't hurt yourself or others.

S715

CAUTION: Risk of injuries and accidents due to heavy weight
- Wear skid-proof gloves and safety shoes with lifting the device.
- Do not load the cable inlets or gas connections.

S720 Ex/S721 Ex

CAUTION: Risk of injuries and accidents due to heavy weight and complex enclosure parts
An S720 Ex/S721 Ex consists of multiple heavy enclosure parts which are connected with fixed cables. The analyzer enclosure weighs at least 75 kg (S720 Ex) and/or 115 kg (S721 Ex).
- Call for some helping hands to transport the complete device.
- Wear skid-proof gloves and safety shoes.
- Do not load the cable inlets or gas connections.

4.3 Safety information on installation

4.3.1 Safety in potentially explosive atmospheres

WARNING: Risk of explosion for S710/S711/S715
- ▶ Do not use a S710/S710 CSA, S711/S711 CSA, S715 standard or S715 CSA in potentially explosive atmospheres.

This enclosure type is not suitable for this use.

WARNING: Risk of explosion for S720 Ex/S721 Ex/
- ▶ *If a S715 EX, S715 EX CSA, S720 Ex or S721 Ex is used in a potentially explosive atmosphere:* Carefully observe the relevant information on the enclosure type.
  - see “S715 EX · S715 EX CSA”, page 21
  - see “S720 Ex/S721 Ex”, page 22

4.3.2 Safety measures against dangerous gases

If the sample gases or auxiliary gases can be dangerous to health:

Protection against dangerous sample gases

WARNING: Health risks through sample gas

If the sample gas can be dangerous to health:

Escaping sample gas can be an acute danger for persons. The concept of the measuring system must contain the required safety measures for health protection. These safety measures must be installed and adhered to. [1]
- ▶ Ensure that all persons involved are informed on the sample gas composition as well as know and adhere to the relevant safety measured concerning health protection.
- ▶ Ensure that a leak in the gas path is detected as operational malfunction and relevant safety measures are then taken.
- ▶ *If leaks are suspected:* Perform a leak tightness check (see “Leak tightness check of sample gas path”, page 176).
- ▶ *Prior to maintenance work:* Purge the gas paths with a neutral gas until the dangerous gases have been completely eliminated.
- ▶ *If sample gas has escaped:* Take breathing protection precautions.

[1] The operating company is responsible for the composition of the sample gas. The operating company has to ensure the relevant safety measures.

Constructive safety measures (examples)

- ▶ *S710/S711:* Capsule the enclosure in a gas-tight outer housing. Purge the outer housing with a neutral gas; discharge the purge gas at a safe location.
- ▶ *S715/S720 Ex/S721 Ex:* Purge the enclosure with a neutral gas (see “Purge gas connections (option)”, page 43); discharge the purge gas at a safe location.

Further safety measures (example)

- Attach warning signs to the gas analyzer.
- Attach warning signs at the entry to the operational room.
- Inform persons who can be in the area on risks and required safety measures.

4.3.3 General safety information on installation

WARNING: Danger due to unsafe device state

- *If severe damage is visible on or in the device:* Take the device out of operation and secure against unauthorised start-up.
- *If liquids have penetrated the enclosure:* Immediately take the device out of operation and disconnect the power voltage at an external source (e.g. pull the power plug).

CAUTION: Risks during maintenance works

- *If it is necessary to open the device for setting or repair:* Disconnect the device from all power sources before starting work.
- *If the open device must be live during work:* This work must be performed by skilled persons who are familiar with potential hazards. If it is necessary to remove or open internal components, live parts could be exposed.
- Never interrupt protective conductor connections.

NOTE: Sensitive electronics

Before signal connections are established (also with plug connections):

- Disconnect the S700 and connected devices from power (switch-off).

Otherwise the internal electronics could be damaged.

NOTE: Gas analysis system incompatible with liquids

If liquids occur in the internal gas paths, this will usually make the gas analyzer unusable. Liquids can be produced by condensation.

- Prevent condensation in the sample gas path of the gas analyzer.

If the sample gas contains condensable components:

- Only operate the gas analyzer in conjunction with an appropriate sample gas conditioning system (see “Designing the sample gas feed”, page 37).
- Before taking the gas analyzer out of operation, always purge its internal gas path with a neutral gas which does not contain condensable components.

NOTE: Responsibility for system safety

The installer of the system is responsible for the safety of the system in which the gas analyzer is integrated.

4.4 Mounting the enclosure

4.4.1 Mounting location, ambient conditions

Inclination

- ▶ Mount the S700 in such a way that the enclosure base is approximately horizontal (for S720 Ex/S721 Ex: the base of the analyzer enclosure).

Quiet running

- ▶ Select an installation location free from vibration.
- ▶ Protect the S700 from hard shocks.

Temperature

- ▶ Maintain the specified ambient temperature during operation (see “Ambient conditions”, page 214).
- ▶ Avoid exposure to direct sunlight.
- ▶ Do not block the air circulation on the cooling fins of the enclosure.

Humidity

- ▶ Install the gas analyzer in a dry and frost-free place.
- ▶ Maintain the permitted air humidity (see “Ambient conditions”, page 214).
- ▶ Make sure that moisture condensation does not occur – both outside and inside the enclosure.

WARNING: Risk of explosion
- ▶ Observe the application limitations for use in potentially explosive atmospheres (see “Application limitations (overview)”, page 16).

WARNING: Risk of explosion (only for S715 EX/S715 EX CSA)
The tightness of the enclosure of an S715 can be affected by strong heating-up of the enclosure (e.g. by direct sunlight). In such a case, the conditions for the use in potentially explosive atmospheres of zone 2 would no longer be fulfilled.
- ▶ Carefully adhere to the temperature conditions for the S715 EX in potentially explosive atmospheres (zone 2).

NOTE: Consequences of incorrect mounting:
- The specified measuring precision will not be achieved.
- Sporadic measurement errors might occur.
- The overall measuring function could be affected.

4.4.2 Enclosure installation

CAUTION: Accident risk through inadequate fastening of the device
- Consider the device weight specifications when planning the mounting supports.
- Check the load capacity/condition of the wall/rack on/in which the device is to be installed.

- Weight specifications (mass), see “Enclosure specifications”, page 213.
- Enclosure and mounting dimensions, see “Dimensions”, page 211.

S710/S711

- Install the enclosure in a standard 19" rack or an appropriate outer housing, in the usual way.

NOTE:
- Use rack rails to carry the weight of the enclosure.
- Do not use the front panel as the only fixing of the enclosure.

Otherwise the enclosure might be damaged.

If another device is installed above the S700, with an installation depth which is not significantly smaller, then it is a good idea not to mount the instruments directly one above the other, but to leave a vertical gap of at least 1 height unit. This will improve the temperature conditions.

S715

- Install the mounting brackets either at top and bottom of the enclosure or at its sides, just as required.
- Mount the enclosure on a stable wall or vertical rack.

S720 Ex/S721 Ex

The enclosure consists of three parts (see “Characteristics of the enclosure types”, page 19). Each of these parts can be installed separately from one another as far as the connecting cable allows. The keypad has a magnetic back.

- Mount the analyzer unit and the display unit on a solid wall or stable rack.
- Place the keypad in an appropriate position.

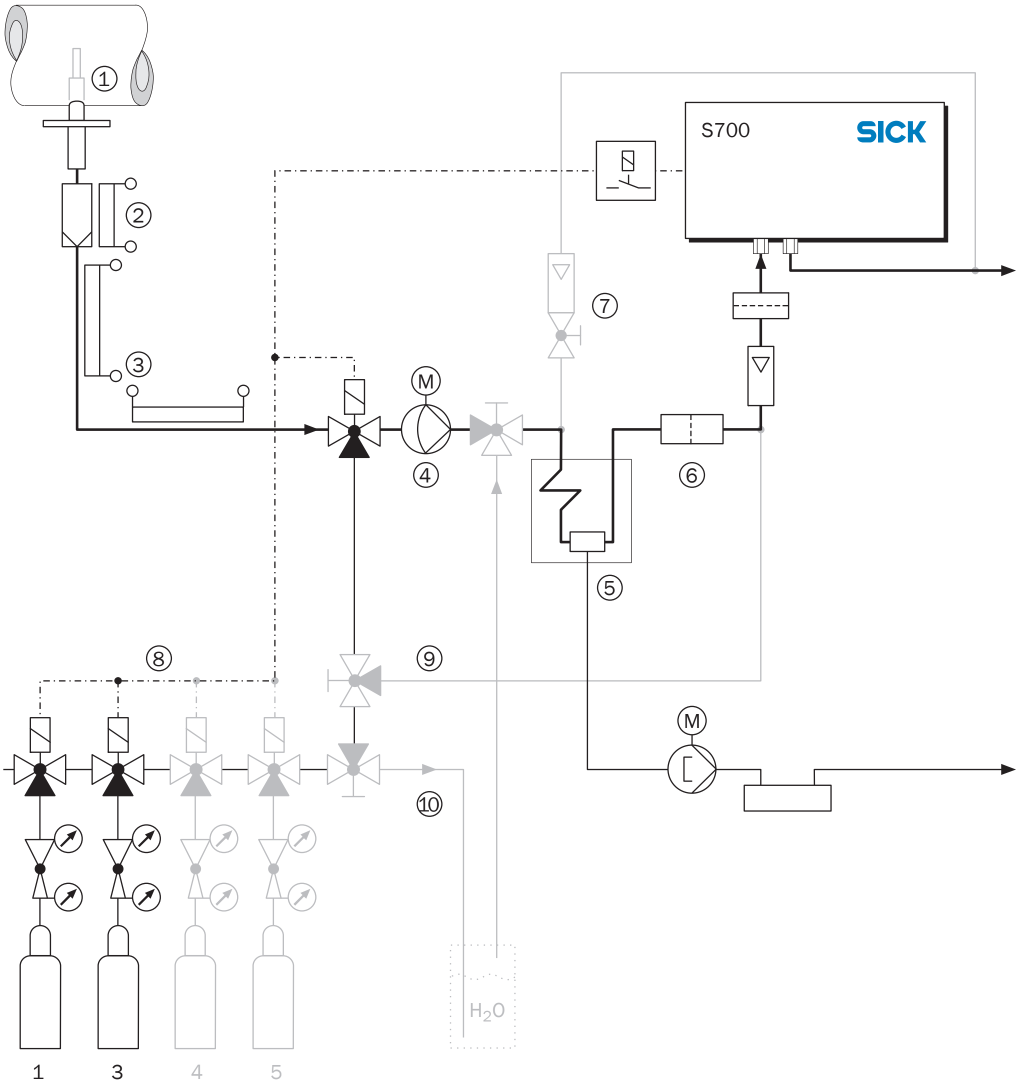
4.5 Sample gas connections

4.5.1 Designing the sample gas feed

In most cases, the gas analyzer is a component of a measuring system. A suitable design of the entire measuring system is required to achieve trouble-free measuring operation, good measuring data, and a minimum of maintenance. Important criteria are, for example, correct choice of the sampling point, appropriate devices for sample gas feed and a careful installation. These items are as essential to the success of measurement as the analyzer itself.

The following diagrams are examples for a proper sample gas feed.

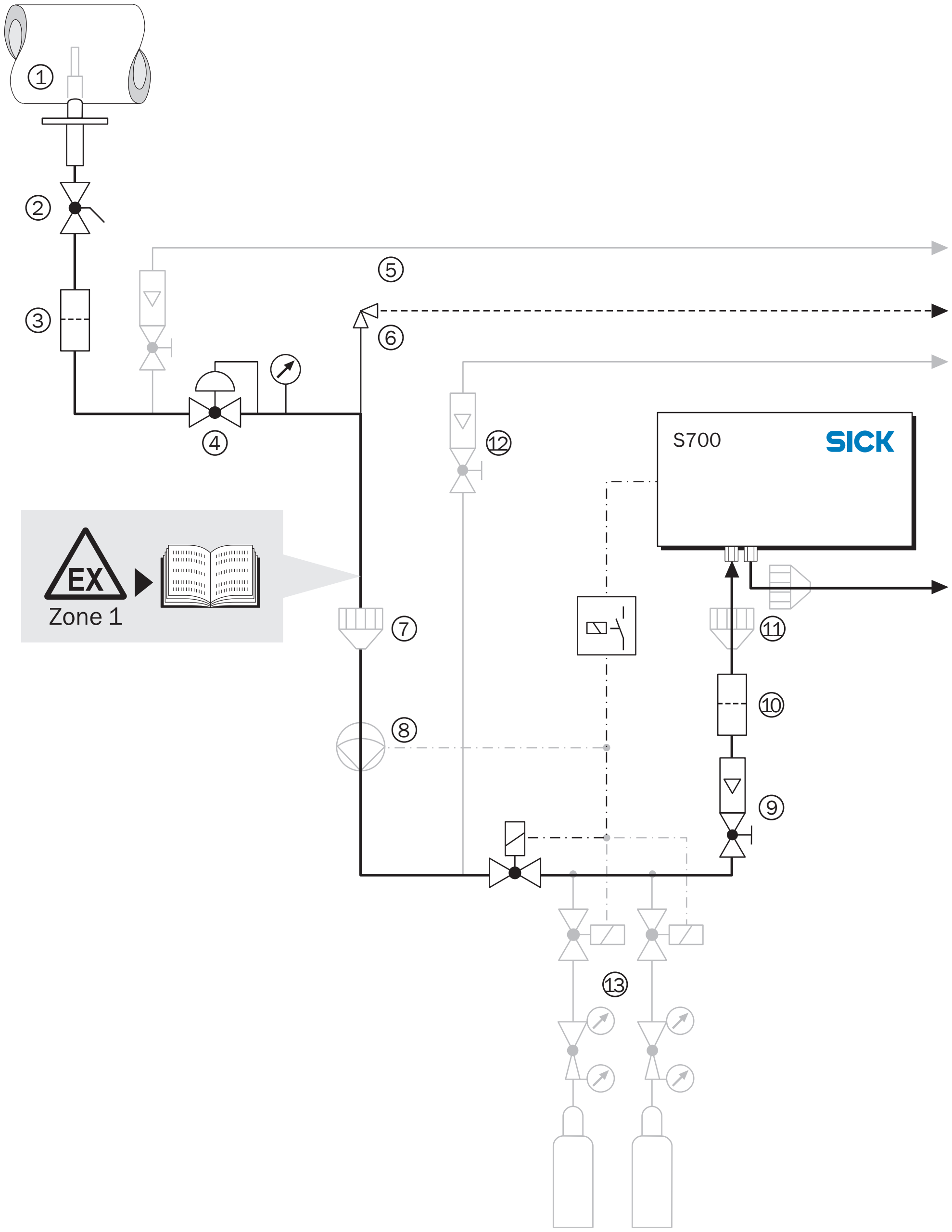
Fig. 3: Sample gas feed from an emission source (example)



If you intend to use an NO_X converter in order to measure the total nitric oxide concentration ($NO+NO_2$) with a NO gas analyzer, please observe the information in see “Information on using a NOX converter”, page 202.

Legend for Fig. 3, page 37-	
1	*Sampling point:* When extracting the sample gas from large containers or large duct cross sections (e.g. chimneys), the gas mixture must be homogeneous at the sampling point. If stratification in the gas flow is expected, you should test the entire cross-section of the gas stream to find the best location of the sampling probe. Please observe the operating instructions of the sampling system.
2	*Dust filter:* Always install a dust filter in the sample gas feed to protect the measuring system against contamination. Even if the sample gas is free of particles, install a dust filter as safety filter to protect the gas analyzer in case of operational malfunctions and defects. – If the sample gas contains condensable components (e.g. water vapor - “wet gas”), the filter needs to be heated. Gas sampling probes with integrated filters at the tip of the sampling pipe are also available so that the filter heating is not needed.
3	*Heated sample gas line:* Use a heated sample gas line if the temperature around the sample gas line may fall below the freezing point or if the temperature in the sample gas line may fall below the dew point of sample gas components. This will prevent the sample gas line from being blocked by ice or condensate.
4	*Gas pump:* If a separate gas pump is installed, the power supply of this pump should be controlled via a switching output of the S700 (see “Available switching functions”, page 98). Thus, the gas pump automatically remains switched off as long as the gas analyzer is not ready for operation.
5	*Sample gas cooler:* The components in the sample gas must not fall below their dew point in the gas analyzer, as condensate in the gas paths makes the gas analyzer unusable. A sample gas cooler can be used to prevent this effect (detailed information, see “Information on using a sample gas cooler”, page 200).
6	*Fine dust filter*: Always install a fine dust filter in front of the sample gas inlet of the gas analyzer - even if another dust filter is already fitted in the sample gas path. This will protect the optical system of the gas analyzer against immediate contamination in case of operational malfunctions (for example, when the other dust filter fails to work) and against slow “hidden” contaminations (for example, caused by valve abrasion of pumps).
7	*Analyzer bypass* (if required): Increases the sample gas volume flow from the sampling point and thus reduces the measuring delay (lag time).
8	*Calibration gases:* During a calibration, calibration gases must be fed into the gas analyzer. In most cases, the calibration gases should flow into the analyzer under the same conditions as the sample gas – which means, flowing through the complete gas conditioning system. However, for some applications special criteria must be observed (see “Special notes”, page 194). Calibration gas feed can be automatically controlled if you set-up the required switching outputs (see “Available switching functions”, page 98). This is the basis for fully-automatic calibrations (see “Requirements for automatic calibrations”, page 133) and it makes manual calibrations easier (see “Automatic calibration”, page 133).
9	*Bypass for sample gas cooler:* Useful for zero point calibration of H_2O (see “Calibration of the H20 measurement”, page 151) and for calibration of an H_2O cross-sensitivity compensation (see “Calibration of cross-sensitivity compensations (option)”, page 154).
10	*Bypass for H_2O calibration:* Useful for an H_2O cross-sensitivity calibration, because the test gas must be manufactured “manually” (see “Calibration of the H20 measurement”, page 151).

Fig. 4: Sample gas feed from a production process (example)



Legend for Fig. 4, page 39-	
1	*Sampling point:* When extracting sample gas from large containers or large duct cross-sections, the sample gas mixture must be homogeneous at the sampling point. If stratification in the gas flow is expected, you should test the entire cross-section of the gas stream to find the best location of the sampling probe. Please observe the Operating Instructions of the sampling system.
2	*Shut-off valve:* Useful to isolate the analysis system from the industrial process if necessary.
3	*Dust:* Always install a dust filter in the sample gas feed to protect the measuring system against contamination. Even if the sample gas is free of particles, install a dust filter as safety filter to protect the gas analyzer in case of operational malfunctions and defects.
4	*Pressure reducer:* Adjusts the sample gas pressure to the requirements of the gas analyzer.
5	*Slipstream bypass* (if required): Increases the sample gas volume flow from the sampling point to the pressure reducer and thus reduces the measuring delay (lag time).
6	*Bypass valve or* bursting disk: Protects the gas analyzer from high pressure if the slipstream pressure reducer fails.
7	*Flame arrester in the sample gas flow:* Prevents inflamed gas from flowing into the gas analyzer or that ignited gas from the gas analyzer endangers the process.
8	*Sample gas pump:* Feeds the sample gas to the gas analyzer. This is required if the sample gas pressure is not sufficient. – Please observe to the following notes: – If dust or particles could pass through the pump (for example, as a result of valve abrasion), then you should install an additional particle filter after the pump. – The power supply of this pump should be controlled via a switching output (see “Available switching functions”, page 98). Thus, the gas pump automatically remains switched off as long as the gas analyzer is not ready for operation. – If the S700 is equipped with a fitted gas pump (see “Optional equipment”, page 27), use the internal pump capacity setting to set the desired volume flow, see “Setting the capacity of the gas pump”, page 114).
9	*Control valve:* Setting the correct sample gas volume flow. (Not needed if the S700 has a fitted gas pump; see “Setting the capacity of the gas pump”, page 114).
10	*Fine dust filter*: Always install a fine dust filter in front of the sample gas inlet of the S700 – even if another dust filter is already fitted in the sample gas path. This will protect the optical system of the gas analyzer against immediate contamination in case of operational malfunctions (for example, when the other dust filter fails to work) and against slow “hidden” contaminations (for example, caused by valve abrasion of pumps).
11	*Flame arresters on the gas analyzer:* Prevents ignited gas from flowing from the gas analyzer back to the process in case of an operational malfunction. This might be mandatory in potentially explosive atmospheres. [1]
12	*Analyzer bypass* (if required): Increases the sample gas volume flow to the gas analyzer. Install an analyzer bypass if a quick response time is required.
13	*Supply of calibration gases* see page 38.

[1] The enclosure type S720 Ex/S721 Ex has fitted flame arresters.

4.5.2 Connecting the sample gas inlet (SAMPLE)

S700 standard versions have a single internal gas path to which all analyzer modules are connected. Special versions may have 2 or 3 internal gas paths (see “Connecting the additional gas paths (REF./REF. OUT – optional)”, page 42).

- ▶ Feed the sample gas via the connection SAMPLE into the S700.
- ▶ Operating conditions (pressure/volume flow/temperature): see “Gas technical requirements”, page 216.

Safe sampling conditions

WARNING: Health risk by poisonous sample gas

- ▶ *When the sample gas is toxic:* Check whether additional safety precautions are necessary (see “Responsibility of user”, page 17).

WARNING: Risk of explosion due to combustible sample gases

- ▶ *When the sample gas can be combustible:* Observe the relevant application limitations (see “Characteristics of the enclosure types”, page 19).

- ▶ *Before the sample gas is fed:* Check whether the sample gas can chemically attack the sample gas path materials (see “Materials in contact with the sample gas”, page 218).
- ▶ Prevent that any liquids can enter the sample gas path of the gas analyzer.
- ▶ Prevent condensation in the sample gas path of the gas analyzer. If the sample gas contains condensable components, then you should only operate the gas analyzer in conjunction with an appropriate gas conditioning system (see “Designing the sample gas feed”, page 37).
- ▶ Always install an external fine dust filter in the sample gas feed to protect the gas analyzer against contamination.[1]

[1] Even if the sample gas is free of particles, install a dust filter as safety filter to protect the gas analyzer in case of operational malfunctions and defects.

Safe installation in potentially explosive atmospheres

WARNING: Risks in potentially explosive atmospheres

When the S700 is used in a potentially explosive atmosphere:

- ▶ Observe application limitations and application requirements.
  - – see “Application limitations (overview)”, page 16;
  - – see “Characteristics of the enclosure types”, page 19.
- ▶ *Before the first start-up:* Check all installed sample gas inlets and outlets with 150 % of the maximum line pressure for leak tightness and tightness.

4.5.3 Connecting the sample gas outlet (OUTLET)

▶ Connect the OUTLET fitting to a suitable collection point (e. g. exhaust gas channel).

CAUTION: Risk of incorrect measurements

The sample gas should not enter the enclosure.

▶ Make sure that the sample gas outlet is discharged properly.

At the sample gas outlet, no significant counter-pressure may built-up, and no strong pressure fluctuations may occur.

▶ Make sure that the sample gas can "freely" exit the gas analyzer.

The pressure at the sample gas outlet should not be increased significantly. Installing a throttle valve at the sample gas outlet is not permissible.

▶ Install a control valve to set the volume flow only before the sample gas inlet.

Otherwise significant measurement errors might occur.

4.5.4 Connecting the additional gas paths (REF./REF. OUT – optional)

Only applies to analyzers with REF. and/or REF. OUT gas connections

Versions equipped with a REF. and/or REF. OUT gas connection have 2 or 3 separate internal gas paths (special version). The internal gas paths may have a common outlet or separate outlets. The actual gas path configuration is specified in the individual information delivered with the gas analyzer.

▶ Use the REF. connection (if existing) to feed the span gas or the second sample gas. Maintain the same operating conditions as for the SAMPLE connection (see "Connecting the sample gas inlet (SAMPLE)", page 41).

▶ Connect the REF. OUT fitting (if existing) to a suitable collection point. Maintain the same operating conditions as for the OUTLET connection (see "Connecting the sample gas outlet (OUTLET)").

▶ Observe any delivered information on the individual gas analyzer with higher priority.

During a zero point calibration, the span gas must be fed as "zero gas" via the sample gas path. It can be advantageous to install an appropriate connection line.

4.6 Purge gas connections (option)

Only applies to analyzers with PURGE IN/PURGE OUT gas connections

S710/S711

▶ *If required:* Feed purge gas via the connection PURGE IN into the enclosure (operating conditions at user's choice).

S715

▶ *If required:* Feed purge gas through the enclosure via the connections PURGE IN and PURGE OUT.

- The enclosure of the S715 EX is “vapor-proof” according to EN 60079. (Criterion: It takes more than 90 seconds for the partial vacuum in a closed enclosure to increase from 3 mbar to 1.5 mbar.)
- If the S715 EX is used in a potentially explosive atmosphere (zone 2), it must be possible to open or close the purge gas connections during a leak tightness check of the enclosure (see “Leak tightness check for the enclosure S715 EX”, page 178).

CAUTION: Safety risks

▶ *If purge gas connections are supplied, but not used:* Seal the purge gas connections so that they are jet-water tight.

Otherwise the specified enclosure protection is not maintained.

S720 Ex/S721 Ex

▶ *If required:* Feed purge gas through the analyzer enclosure via the connections PURGE IN and PURGE OUT.

CAUTION: Risks in potentially explosive atmospheres

▶ Use steel tubing for all the purge gas lines if the related requirements apply (see “Safe installation in potentially explosive atmospheres”, page 41).

▶ Set-up the purge gas feed in such a way that the purge gas pressure does not exceed 100 mbar (referred to the ATEX certification.

▶ Close unused purge gas connections either “flame tight” (nearly gas-tight) or replace them with closure claps which are certified for potentially explosive atmospheres (thread: ISO 228/1 - G 1/4). Apply “Loctite 243” adhesive to the threads and sealing surfaces.

4.7 Opening and closing the enclosure

4.7.1 Safety precautions before opening the enclosure

WARNING: Health risks during maintenance work

If the sample gas can be dangerous to health: Escaping sample gas can be an acute danger for persons.

Before opening gas paths (e.g. to clean the filter):

- ▶ Purge gas paths with a neutral gas until the dangerous gases have been completely eliminated.
- ▶ Take breathing protection precautions as necessary for safety.

WARNING: Health risks (information)

- ▶ Observe the safety information on decontamination (see page 173).
- ▶ Observe the safety information on possible risks through gas from internal components (see page 173).

WARNING: Accidents risks in special cases

- When the S700 measures toxic, dangerous or combustible gases;
- When the S700 is located in a potentially explosive atmosphere;
- When it is suspected that the internal gas paths have a leak:

Perform the following measures before opening the enclosure:

1. Shut off any gas feed to the S700, except for the purge gas feed (if existing).
2. Switch off the power supply to the S700 at an external point.
3. *In potentially explosive atmospheres:* Disconnect the S700 from all external voltages (e.g. signal lines). Exception: Connections to intrinsically safe power circuits can remain connected.
4. *For the S720 Ex/S721 Ex:* Wait for the minimum waiting time specified on the analyzer unit to elapse.
5. *If an enclosure purging is installed:* Wait an appropriate time for the enclosure to be purged with inert gas.
6. If required, take protective measures to protect against escaping gases (for example, breathing protection equipment, suction removal of gases).
7. As soon as the enclosure is opened, the specified enclosure protection and the related explosion protection is no longer valid. Observe all related safety regulations that are valid for your location.
8. Only open the enclosure when it is truly safe to do so.

NOTE:

Electrostatic voltage can damage or destroy electronic components.

- ▶ *Before touching electrical connections and internal components:* Earth your body and tools used to discharge electrostatic charges.

Recommended method:

- ▶ *If the power connection including the protective conductor is installed:* Touch a blank metal part of the enclosure.
- ▶ *Otherwise:* Touch an “external” blank metal surface which is connected to the protective conductor or has safe contact to earthing.

4.7.2 Opening the enclosure

- For the S715, S720 Ex and S721 Ex, the enclosure has to be opened to connect electrical connections.
- The enclosure of the S710/S711 does not need to be opened for installation work.

WARNING: Health/accident risks

▶ Observe the safety information on opening the enclosure (see “Safety precautions before opening the enclosure”, page 44).

S715

1 Loosen both screws of the relevant front doors (suitable wrench in scope of delivery).
2 Swing the front door to the left.

S720 Ex/S721 Ex

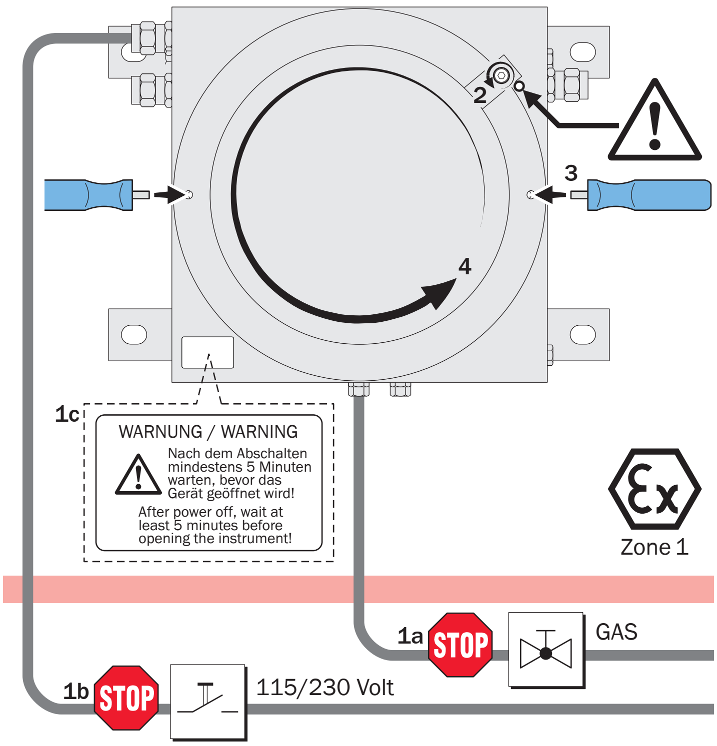
CAUTION: Risk of personal injury

- There is a strong pin on the front of the analyzer enclosure.
- The weight of the front cover is approx. 5 kg (11 lb.).

▶ Wear slip-safe hand gloves and safety shoes when opening the front cover.

1 Loosen the fixing screw on the front cover of the analyzer unit (see Fig. 5).
2 Insert the tool aids into the front cover holes.
3 Loosen the front cover (max. 2 rotations). Remove the tool aids.
4 Unscrew the front cover by hand.

Fig. 5: Opening the analyzer enclosure for S720 Ex/S721 Ex



4.7.3 Closing the enclosure

WARNING: Explosion/Health risk
- ▶ Keep the enclosure completely closed during operation.

Otherwise the specified explosion protection or enclosure protection is not ensured.

S715

- ▶ Close the front doors jet-water tight (tighten the front screws) before starting-up the analyzer.
- ▶ Also close all other enclosure openings jet-water tight.
- ▶ Close the cable inlets jet-water tight when the cable installation has been made.
- ▶ Replace all unused cable inlets with appropriate closing caps (see “Correct use of the cable inlets”, page 47).

S715 EX/S715 EX CSA additionally (in potentially explosive atmospheres):

- ▶ If the enclosure had been opened, perform a leak test (see “Leak tightness check for the enclosure S715 EX”, page 178).

S720 Ex/S721 Ex

- ▶ Tightly close the front covers of both enclosure units.
- ▶ Fix the front cover of the analyzer unit by tightened the fixing screw.
- ▶ Close all the used cable inlets “flame-tight” (nearly gas-tight).
- ▶ Close-off unused cable inlets properly (see “Correct use of the cable inlets”, page 47).

4.8 Cable installation (S715/S720 Ex/S721 Ex)

4.8.1 Suitable cables for potentially explosive atmospheres

WARNING: Risk of explosion through wrong cable material

In potentially explosive atmospheres:

▶ Only use cables for the electrical connections which meet the requirements of standard EN 60079-14.

EN 60079-14 states criteria for:

- Geometry
- Materials
- Gas-tightness, vapor tightness
- Resistance against water and water vapor
- Dielectric strength

4.8.2 Correct use of the cable inlets

WARNING: Risk of explosion

Permitted cable diameter:

▶ Only use cables which are suitable for cable inlets:
  - *S715:* Outer diameter of the cable = 7 ...12 mm.
  - *S720 Ex/S721 Ex:* Outer diameter of the cable = 7 ...12 mm or 10 ...16 mm, depending on the enclosure version. [1]

Cable inlets:

▶ *S715:* Before start-up in a potentially explosive atmosphere, close all cable inlets “vapor-proof” (nearly gas-tight).

▶ *S720 Ex/S721 Ex:* Before start-up in a potentially explosive atmosphere, all cable inlets have to be “flame-tight” (nearly gas-tight).

▶ Seal unused cable inlets “flame-tight” (nearly gas-tight), either with a sealing plug or by replacing the cable gland with a closing cap.
  - *Sealing plugs:* Select to match the allowable cable diameter and fit instead of a cable.
  - *Closure caps:* Select closure caps with thread M20x1.5 which are specified for use in potentially explosive atmospheres. Apply “Loctite 243” adhesive on all threads and sealing surfaces.

[1] Currently 7 ...12 mm, in future 10 ...16 mm. Please check the version of the delivered enclosure.

The cable inlets are subject of the ATEX certification.

▶ *If the device is used in a potentially explosive atmosphere:* Do not replace the cable inlets with cable inlets of a different type.

4.8.3 Correct installation of signal cables

S715 EX/S715 EX CSA

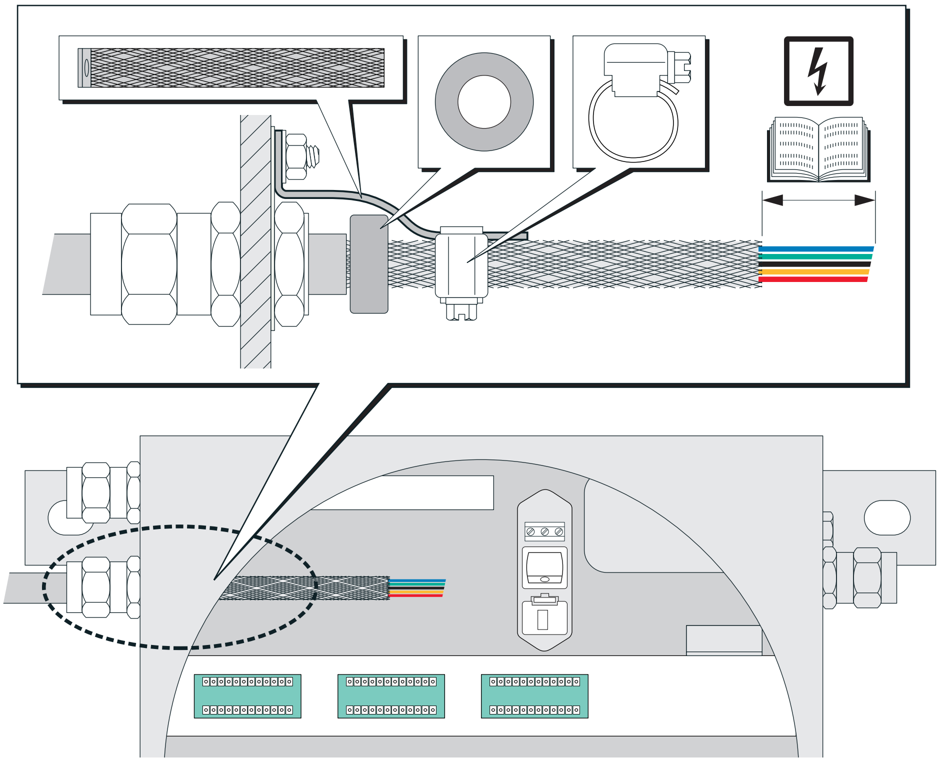
- *In a potentially explosive atmosphere (zone 2):* Install all connected cables “fixed”, i.e. fasten the cables along the whole length.

S720 Ex/S721 Ex

- *In a potentially explosive atmosphere:* Install all connected cables “fixed”, i.e. fasten the cables along the whole length.
- *To reach the specified interference immunity:* Install the signal cables inside the enclosure as follows (see Fig. 6):

1 Remove the outer insulation shield from the signal cable between cable end and cable inlet; however, leave the metal cable shield on the cable, as far as possible – remove the cable shield only where it is required to connect the cable ends.
2 Push a ferrite ring (in scope of delivery) over the signal cable.
3 Connect the supplied wired metal stripe to the threaded bolt next to the cable gland.
4 Use the supplied metal hose clamp to connect the wired metal strip to the cable shield. Use a metal hose clamp (in scope of delivery).
   - Make a good electrical connection.
   - Use the hose clamp also to keep the ferrite ring close to the cable gland.

Fig. 6: Installation of signal cables for S720 Ex/S721 Ex



4.9 Power connection

4.9.1 Safety information for power connection

Electrical safety through lines with correct rating

WARNING: Endangerment of electrical safety through incorrect measurement of the power cable

When a removable power cable is used, electrical accidents can occur when the specifications are not fully observed.

- *If a removable power cable has to be replaced:* Observe the exact specifications (→ Supplementary Operating Instructions of the enclosure).

Grounding the devices

CAUTION: Device damage through incorrect or missing grounding

- Ensure that the protective grounding to the affected devices or lines is effective in accordance with EN 61010-1 during installation and maintenance work.

CAUTION: Health risk

- Only connect the device to a main power supply with a functional protective conductor (protective earth, PE).
- Only start the device when a correct protective conductor connection is installed.
- Never interrupt a protective conductor connection (yellow-green cable) inside or outside the enclosure.

Otherwise electric safety is not ensured.

Correct power voltage

CAUTION: Damage or malfunction by wrong power supply

The power voltage must match the power voltage setting shown on the S700 type plate,. The power voltage frequency must match the data on the S700 type plate.

- If the mains voltage is too high, then the S700 can severely be damaged. The S700 can be dangerous when operated in such a damaged state.
- If the mains voltage is too low, the S700 will not work correctly.

- Ensure that the power voltage setting matches the existing power voltage (see Fig. 7, page 51 / Fig. 8, page 52- / Fig. 9, page 53-).
- Adapt the setting if required (see “Adapting to power voltage”, page 184).

Electrical safety through disconnector switch

see “Installing a separate disconnector switch”.

EX

The internal main power switch (S715/S720 Ex/S721 Ex) may only be used for service work outside potentially explosive atmospheres.

4.9.2 Using a separate mains fuse

- In addition, install an individual external mains fuse for the S700. Fuse rating: T 10 A.

After power-on, for a very short time, the S700 draws a much higher current than specified for operation (approx. 40 A for approx. 5 ms). Therefore, external fuses for the S700 power supply should have a slow-blow or delay-action characteristic.

4.9.3 Installing a separate disconnector switch

WARNING: Endangerment of electrical safety through not switching the power supply off during installation and maintenance work

An electrical accident can occur during installation and maintenance work when the power supply to the device and/or lines is not switched off using a disconnector switch/ circuit breaker.

- Before starting the work, ensure the power supply can be switched off using a power isolating switch/circuit breaker in accordance with DIN EN 61010.
- Make sure the disconnector switch is easily accessible.
- *If it is not possible or difficult to reach the disconnector switch after installation of the device connection:* Install an additional disconnecting device.
- The power supply may only be activated by personnel carrying out the work (after installation work or for test purposes). Observe the valid safety regulations.

EX

The internal main power switch (S715/S720 Ex/S721 Ex) may only be used for service work outside the potentially explosive atmospheres.

4.9.4 Connecting the power cable

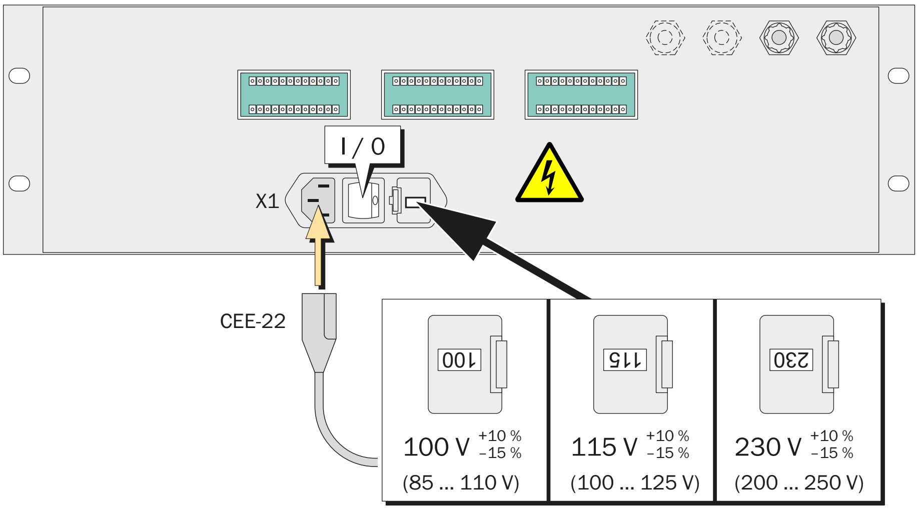
S710/S711

To ensure that the device is not unintentionally starting up:

▶ Ensure that the main power switch is turned off ("0" visible, see Fig. 7).

1 Check if the device is set to the correct power voltage (100/115/230 V see Fig. 7). If required, adapt the setting to your mains power voltage (see "Adapting to power voltage", page 184).
2 Connect the power cable to the built-in plug on the rear panel (standard CEE-22 plug, see Fig. 7).
3 Connect the power cable to an appropriate mains supply (safety information, see "Safety information for power connection", page 49).

Fig. 7: S710/S711 – power connection, main power switch, position of the signal connections



WARNING: Endangerment of electrical safety through incorrect measurement of the power cable

When a removable power cable is used, electrical accidents can occur when the specifications are not fully observed.

▶ *If a removable power cable has to be replaced:* Observe the exact specifications (see "Electrical specifications", page 215).

S715

WARNING: Risk of explosion

In potentially explosive atmospheres:

▶ Connect the PA connection on the outside of the enclosure to the same electrical potential as the internal PE connection.

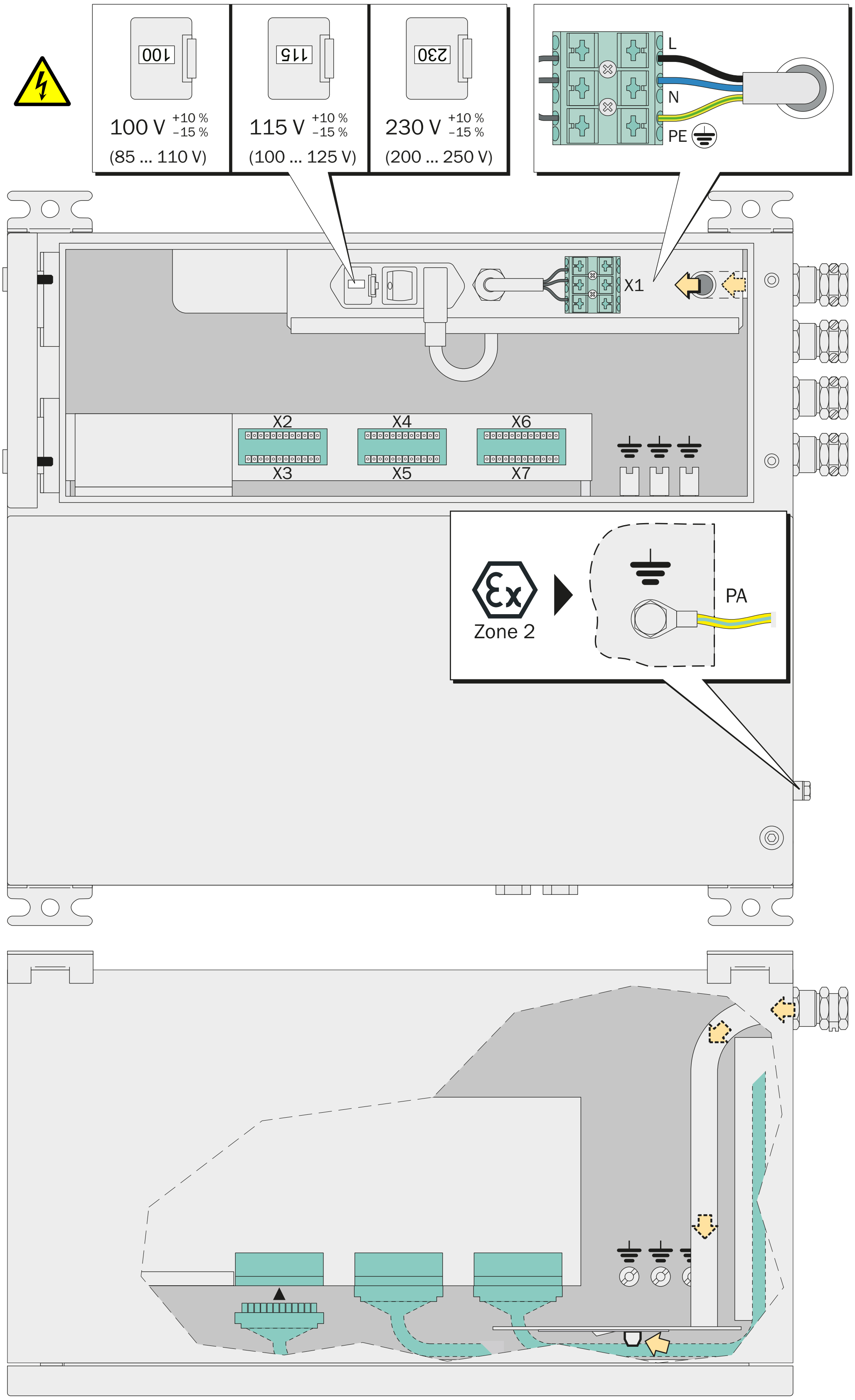
▶ Do not switch-on the mains power as long as the enclosure is open.

WARNING: Health risk

▶ *Before installing the power cable:* Make sure the external main power supply is switched off.

1 Open the top section of the enclosure (see "Opening the enclosure", page 45).
2 Check if the device is set to the correct power voltage (see "Adapting to power voltage").
3 Put the power cable through the upper cable gland.
4 Connect the cable ends to the power connection terminal (PE = Protective Earth, N = Neutral, L = Live).
5 Close the cable gland on the cable.

Fig. 8: S715 – power connection, position of the signal connections



S720 Ex/S721 Ex

WARNING: Risk of explosion

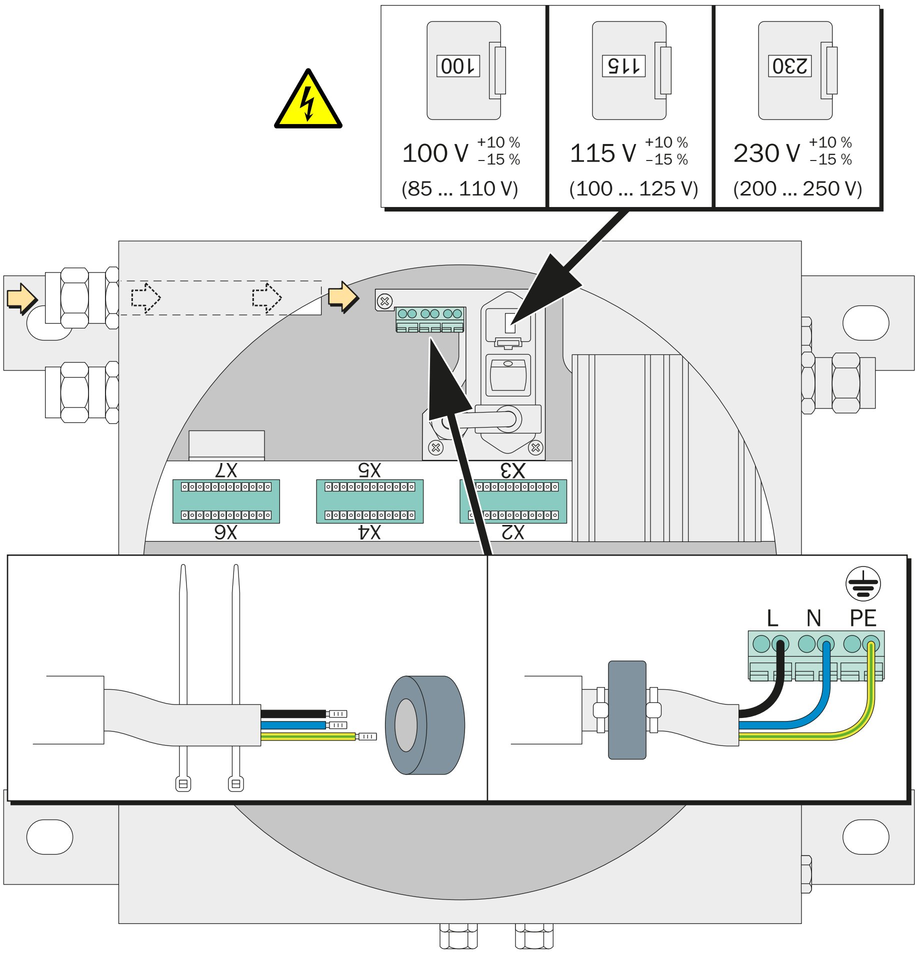
▶ *In potentially explosive atmospheres:* Do not switch on the main power supply as long as the enclosure is open.

WARNING: Health risk

▶ *Before installing the power cable:* Make sure the external main power supply is switched off.

1 Open the analyzer unit (see “Opening and closing the enclosure”, page 44).
2 Check for which power voltage the device is equipped (see “Adapting to power voltage”, page 184).
3 Put the power cable in through a cable gland (see “Cable installation (S715/S720 Ex/ S721 Ex)”, page 47).
4 Inside the enclosure, put the provided ferrite ring onto the mains cable and fix it by means of cable straps (see Fig. 9).
5 Connect the power cable to the power connection terminals (PE = Protective Earth, N = Neutral, L = Live).
6 Close the cable gland until it makes a “flame-tight” (nearly gas-tight) fit around the cable.

Fig. 9: S720 Ex/S721 Ex – power connection and position of the signal connections



4.10 Signal connections

4.10.1 Type of terminal connections

12-pole plug connectors are used for the signal connections. The supplied counterparts are equipped with screw terminals and lock-in housings.

Each S700 connector has one blocked recess as a mechanical code for the connection. On the counterpart, the matching edge must be removed (see Fig. 10).

Fig. 10: S700 plug connector

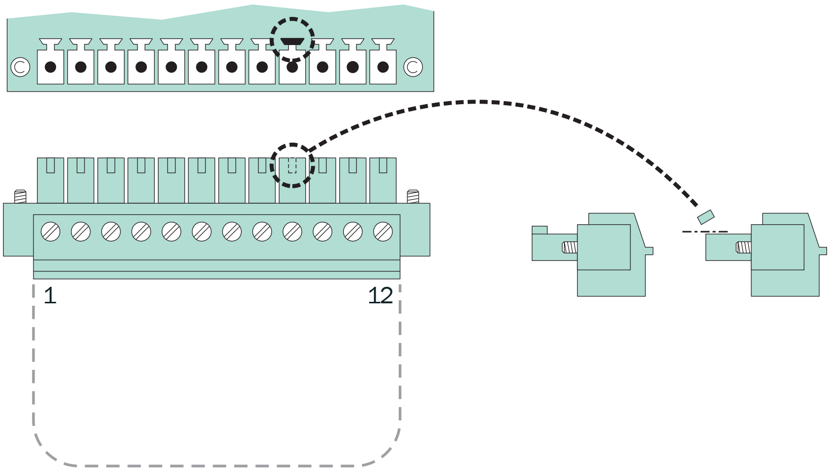


Table 5: Mechanical coding of the plug connectors

Plug connector	X2	X3	X4	X5	X6	X7
Coding on pin no.	2	3	4	5	6	7

NOTE:

Before signal connections are established (also with plug connections):

- ▶ Disconnect the S700 and connected devices from the power supply and potential-free (switch-off).

Otherwise the internal electronics could be damaged.

All exterior power circuits conduct signal low voltages <50V DC.

The option “intrinsically-safe measured value outputs” has additional screw terminals for the measured value outputs (see “Intrinsically-safe measured value outputs”, page 63).

4.10.2 Suitable signal cables

All exterior power circuits only conduct signal low voltages <50V DC.

- ▶ Only use cable material which meets the following requirements is used for signal lines and control lines:
  - – AWG22 (or better)
  - – Insulating strength of > 520 V
- ▶ Use shielded cables for all signal lines. The high-frequency impedance of the shield must be low.
- ▶ Connect only one side of the cable shield to GND/enclosure. When possible, make a short connection with a broad contact.

▶ Observe the shielding concept of the host system (if existing).

NOTE:
▶ Use suitable cables only. Install all the cables properly.
Otherwise the specified EMC protection is not guaranteed, and sporadic and inexplicable functional problems might occur.

WARNING: Endangerment of electrical safety through wrong cables
If external heating lines are powered with power voltage:
▶ Use cable material with a conductor cross-section of at least 3 x 1 mm^2.

4.10.3 Maximum load of the signal connections

Maximum switching contact load

Product version		AC voltage[1]	DC voltage	Current[1]
Standard		max. 30 VAC	max. 48 VDC	max. 500 mA
CSA version[2]	either[3]	max. 30 VAC	max. 48 VDC	max. 50 mA
	or[3]	max. 15 VAC	max. 24 VDC	max. 200 mA
	or[3]	max. 12 VAC	max. 18 VDC	max. 500 mA

Table 6: Maximum permitted load for each of the relay switch contacts [4]

[1] Effective value.
[2] Possible voltage/current combinations in CSA standard range or within the framework of a CSA certification. Identification of a CSA version, see “Product identification”, page 18.
[3] at user’s choice
[4] all voltage values referenced to GND/enclosure

NOTE:
Inductive loads (for example, relays or solenoid valves) may only be connected if discharging diodes are provided.
▶ *For inductive loads:* Check whether discharging diodes are fitted.
▶ *If not:* Install external discharging diodes (see “Anti-inductive protection for the signal connections”, page 56).

Maximum input voltage

- Maximum peak voltages on digital interfaces: ±15 V
- Highest permitted voltage at the opto-coupler inputs:
  - Control voltage: ±24 VDC
  - Peak voltage: 48 V (peak)
- Voltage peaks on the other signal connections: ±48 V (peak).

NOTE:
Any voltage greater than 48 V (even fast peaks) could damage internal components.
▶ Keep external voltages and voltage peaks away from the signal connections.

4.10.4 Outputs for signal voltage (auxiliary voltage)

An auxiliary voltage of 24 VDC is available at the connector pins “24V1” and “24V2”. This can be used as voltage supply for external low-powered devices (for example, relays).

A common internal voltage source supplies both outputs; the allowable amperage is 1 A (24V1 + 24V2). An internal fusible cutout protects against overloads (see “Internal fuses”, page 185).

4.10.5 Anti-inductive protection for the signal connections

Internal EMC filters

There is an EMC filter between the internal electronics and each S700 signal connection. This also applies for the measured value outputs and the digital interfaces; only the mass connections (GND) do not have an EMC filter. These internal EMC filters must be protected against high voltages.

Risks caused by inductive loads

Devices, whose internal electric circuits are equipped with coils or windings with iron core, can produce a countervoltage which can be very much larger than the operating voltage. Such devices are, for example, solenoid valves, pumps, electrical bells, relays, and electrical motors. The induced voltage of such devices can immediately destroy an internal EMC filter. In many cases, a defective EMC filter can short-circuit the signal connection to ground (GND).

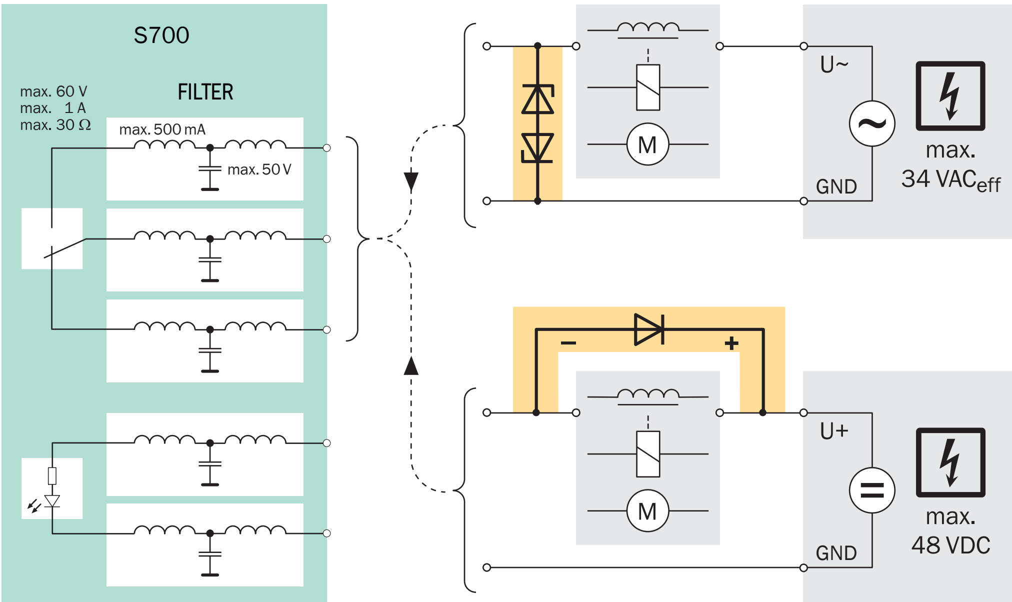
Protective measures

NOTE:

- *If the connected devices can create induced voltages and are not fitted with discharging diodes:* Install one or two “discharging diodes” on each inductive load to discharge any induced voltages (see Fig. 11).

Otherwise internal EMC filters can be destroyed, which will make the entire internal electronics board unusable.

Fig. 11: Connecting inductive loads



Subject to change without notice

4.11 Measured value outputs

Function

The S700 has four measured value outputs for output of the measured values of the measuring components (OUT1 ... OUT4 see Fig. 12, page 58).

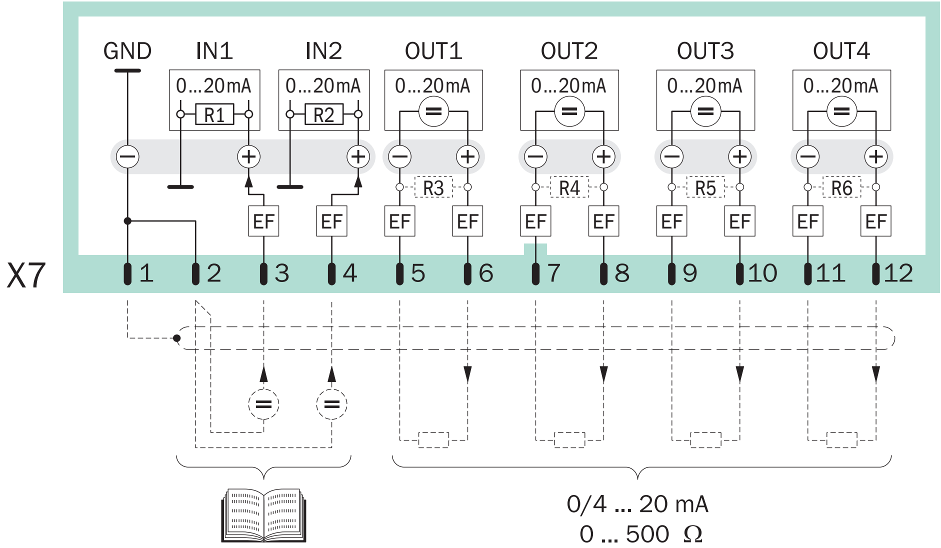
- *Operation:* The S700 measures in a quasi-continuous mode. New measured values are generated approximately every 0.5 ... 20 seconds (depending on the individual application and the number of measuring components).
- *Measuring component:* You can select which measuring component is output on which measured value output (see "Assigning measuring components", page 93); the default assignment corresponds to the displayed order (see "Measuring displays", page 74). *Exception:* For certain sampling point selector configurations (see "Sampling point selector (option)", page 119), each measured value output automatically represents one of the sampling points; detailed information see "Special functions for certain sampling point configurations", page 93.
- *Output ranges:* Each measured value output can signal the measured value in two different output ranges (setting, see "Setting-up the output ranges", page 94; selection of the current output range, see "Selecting the output ranges", page 95). The working output range can be indicated by a status output (see "Available switching functions", page 98).
- *Function during a calibration:* You can select whether the measured value outputs display the test values or the last measured value during calibration (see "Selecting the output mode during calibration", page 96).
- *Behavior at zero point:* You can influence how the measured value outputs behave at the start value of the measuring range (see "Suppressing measured values at the start of the measuring range", page 90). For example, this allows you to prevent negative measured values from being displayed.

Electrical signal

- The measured value outputs are galvanically isolated from the other internal electronics. However, when the minus pole is connected to ground (GND), the isolation is no longer maintained.
- The standard signal is 4 ... 20 mA; allowable load: 0 ... 500 Ω. As an option, voltage signals can be set-up at the factory, for example 0 ... 10 V.
- The electrical display range can be set to 0 ... 100 %, 10 ... 100 % or 20 ... 100 % (corresponds to 0/2/4 ... 20 mA; see "Setting the "live zero"/deactivating a measured value output", page 95).
- Negative electronic output signals are not available.

+i Additional information applies for option "intrinsically-safe measured value outputs" (see "Intrinsically-safe measured value outputs", page 63).

Fig. 12: Plug connector X7 (analog inputs, measured value outputs)



4.12 Analog inputs

Function

The S700 has two inputs for external analog signals (IN1, IN2; see Fig. 12). These two inputs only have to be connected if the S700 software considers these inputs. This applies only to special analyzer versions. Please check if your analyzer was delivered with corresponding technical information.

Possible uses of analog signal inputs (requires a special factory-made configuration):

- External cross-sensitivity compensation (see “Cross-sensitivity and gas matrix effect compensation”, page 26)
- Processing an external measuring signal as an internal measuring component, i.e. displaying the signal value as an S700 measuring component with all related analog and digital outputs – for example, for the measured value of another gas analyzer. This can also include the calibration of this signal, controlled by the S700.
- Calculation of measured values from an external analog signal and displaying these as an S700 measuring component – for example, for the measuring signal of an external sensor.

+i Information on the use of analog inputs can be found in the internal configuration data (output of data, see “Printing internal configuration”, page 104; information, see “Information on active compensations”, page 196).

Electrical signal

- *Input signal:* Set at the factory to voltage signal 0 ... 2 V or current signal 0 ... 20 mA (selectable). The internal resistance is 100 W (default value for R1 and R2). If the internal resistance is too small for a voltage input signal, R1 and R2 can be removed.
- *Highest allowable signal:* 3 V or 30 mA. If this value is exceeded, then the message `FAULT: mA/V input` is displayed.
- The analog inputs are *not* galvanically isolated (minus pole is GND).

4.13 Switching outputs

You can individually make a test for each signal connection without setting or changing any of the S700 functions (see “Testing electronic outputs (hardware test)”, page 121). This allows you, for example, to check the external wiring.

4.13.1 Switch functions

The S700 has 16 switching outputs which you can use in the following way:

- The switching contacts REL1, REL2 and REL3 are used for basic status messages (see “Available switching functions”, page 98). This assignment cannot be changed.
- The switch contacts REL4 ... REL8 and the transistor outputs TR1 ... TR8 can freely be assigned to any of the supplied status or control functions.
  - Which switch functions are available and how the desired assignment is made is described in see “Configuration of the switching outputs”, page 97.
  - A list of all the available switch functions is shown in see “User Table: Switching outputs”, page 209. You may want to use this Table to record your assignments.

4.13.2 Electrical function

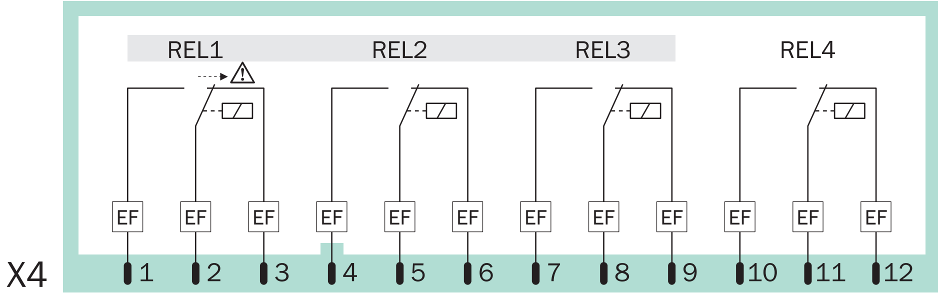
- The switching outputs REL1 ... REL8 are potential-free make&break contacts (see Fig. 13, page 60 and Fig. 14, page 60-).
- The switching outputs TR1 ... TR8 are transistor outputs (see Fig. 15, page 61), used for switching external loads. Use the internal auxiliary voltage for power supply (see “Outputs for signal voltage (auxiliary voltage)”, page 55).
- The switching outputs can be programmed to work according to the open-circuit or the closed-circuit principle (see “Control logic”, page 97).

Transistor outputs can be used to switch a higher load than specified if an external relay is installed between the transistor output and the load:

- Electronic shops offer various relay modules, for example with 8 electro-mechanical relays each. Please make sure that these are equipped with discharging diodes.
- Consider if solid-state relays could be better. Solid-state relays do not require discharging diodes and can directly be connected to the transistor outputs.

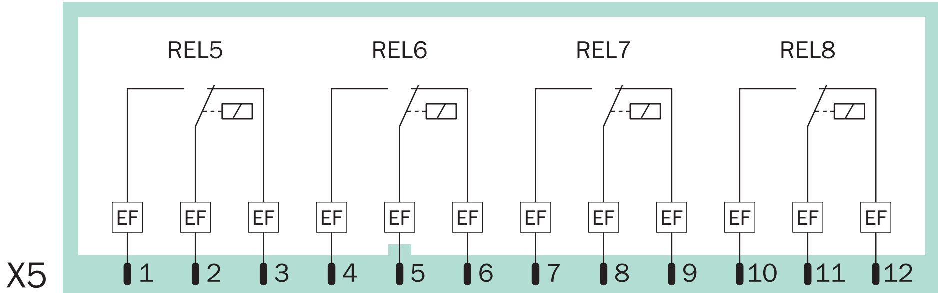
4.13.3 Contact connections (pin assignment)

Fig. 13: Plug connector X4 (relay switching outputs)



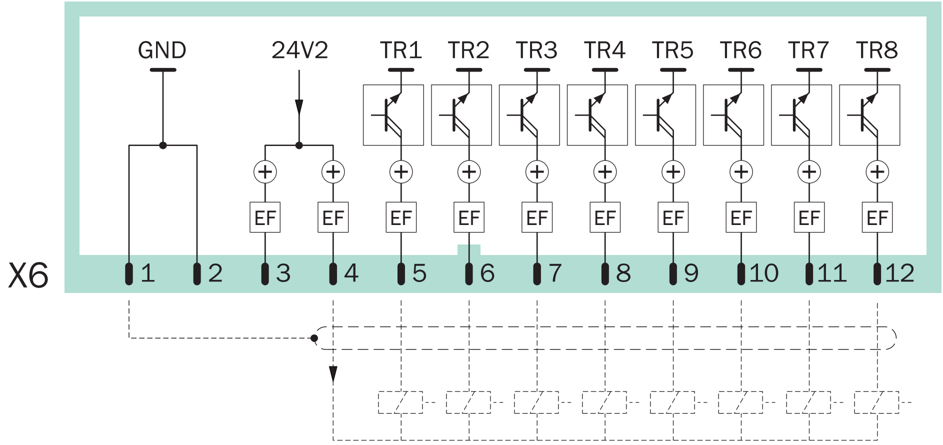
NOTE:
- Observe the maximum contact load of the switching outputs (see “Maximum load of the signal connections”, page 55).
- Keep any voltage higher than 48 V (even fast peaks) away from the signal connections (see “Maximum load of the signal connections”, page 55).
- When connecting inductive loads (for example, relays or solenoid valves), make sure that discharging diodes are installed (see “Anti-inductive protection for the signal connections”, page 56).

Fig. 14: Plug connector X5 (relay switching outputs)



NOTE:
- Observe the same safety notes as for plug connector X4 (see Fig. 13).

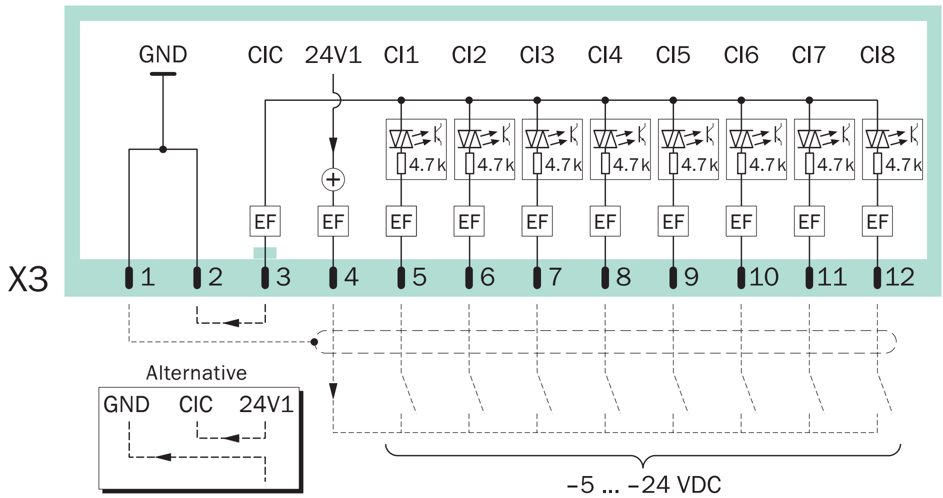
Fig. 15: Plug connector X6 (transistor switching outputs)



NOTE:
- To power these switches, use the internal auxiliary voltage source only (24 VDC see "Outputs for signal voltage (auxiliary voltage)", page 55).
- Observe the highest permitted load (maximum rating):
  - for a single transistor output: ≤ 500 mA (corresponds to ≤ 12 W /external load ≥ 48 Ω)
  - for the total of all transistor outputs: ≤ 1000 mA (24 Ω)

  Higher loads (even short-term or peak) will immediately destroy internal components.
- When connecting inductive loads (for example, relays or solenoid valves), make sure that discharging diodes are installed (see "Anti-inductive protection for the signal connections", page 56).

Fig. 16: Plug connector X3 (control inputs)



NOTE:
- Do not supply more than ±24 VDC for the control voltage.
- Do not exceed the maximum peak voltage: 48 V (peak)

Higher voltages could damage internal components. In addition, the safety separation of functional voltages would no longer be guaranteed.

4.14 Control inputs

4.14.1 Control functions

The S700 has 8 control inputs. Each of the control inputs can be freely assigned to any of the possible control functions (see “Configuration of the control inputs”, page 99).

A list of all the available control functions is shown in see “User Table: Control inputs”, page 210. You may want to use this Table to record your assignments.

4.14.2 Electrical function

The control inputs CI1 ... CI8 are optical coupler inputs (see Fig. 16, page 61).

- *Activation:* The logical function of a signal input is activated when current flows between the control input connection and the common pole of the control inputs (CIC).
- *Control voltage:* ±5 ... ±24 V DC. You can use an external voltage source or the internal auxiliary voltage (24 VDC see “Outputs for signal voltage (auxiliary voltage)”, page 55).
- *Polarity:* The optical coupler inputs are bipolar which means they can be activated selectively with either positive or negative voltage. “Plug connector X3 (control inputs)” shows both alternatives when using an internal auxiliary voltage: The common pole (CIC) is connected either to GND (negative) or to 24V1 (positive).
- *Galvanic separation:* The connections of the optical coupler inlets are electrically isolated, i.e. separated galvanically from the remaining S700 electronics. However, the galvanic isolation is no longer maintained if one of the connections is connected to another non-isolated S700 contact (for example, GND or 24V1).
- *Internal resistance:* 4.7 kΩ per control input.
- *External switch:* Mechanical switching contact or open collector output.

NOTE:

▶ Do not connect the control inputs to voltages greater than 24 V.

Otherwise internal components could be damaged, and the safe separation of functional voltages is no longer guaranteed.

You can test the current state of each individual control input (see “Status of the control inputs”, page 118). This allows you, for example, to check the external wiring.

4.15 Intrinsically-safe measured value outputs

Only applies for enclosures with option "intrinsically-safe measured value outputs".

Function

Intrinsically-safe measured value outputs are realised with fitted additional modules (Zener safety barriers). Up to four measured value outputs are available as intrinsically-safe outputs.

NOTE:
- ▶ Observe the maximum permitted load for the intrinsically-safe outputs:

Damage through overload
- – Allowable load: 0 ... 390 Ω (!)
- – Maximum voltage at the terminal connections: 18 V

WARNING: Safety risk in potentially explosive atmospheres
Intrinsically-safe circuits fulfill special explosion protection requirements. To achieve the desired explosion protection:
- ▶ Provide "intrinsically-safe" devices for all the circuit components.
- ▶ Maintain the specified connection values (see below).
- ▶ Install the entire circuit properly.

Permitted connection values

The intrinsic safety of a intrinsically-safe measured value output will only be achieved if the connected circuit (including the cable lines) conforms to the following values:

Table 7: Permitted connection values for intrinsically-safe meas. value outputs (option)

Electrical parameter of the connected circuit	For protection class Ex-ia, explosion group IIB	For protection class Ex-ia, explosion group IIC
Total inductivity L_A	≤ 9 mH	≤ 2 mH
Total capacity C_A	≤ 580 nF	≤ 90 nF

CAUTION: Individual application may require reduced values
The individual application may require lower values. It depends on the composition of the explosive atmosphere.
- ▶ Check the European Standard EN 60079 -0 "Electrical apparatus for potentially explosive atmospheres" to find out the maximum permitted connection values for your application.
- ▶ *If this results in limitations:* Note these limitations (e.g. in this document) and consider during installation.

+i More information on intrinsically-safe equipment is given in the European Standard EN 60079 -11 "Intrinsic safety "i"".

Connection

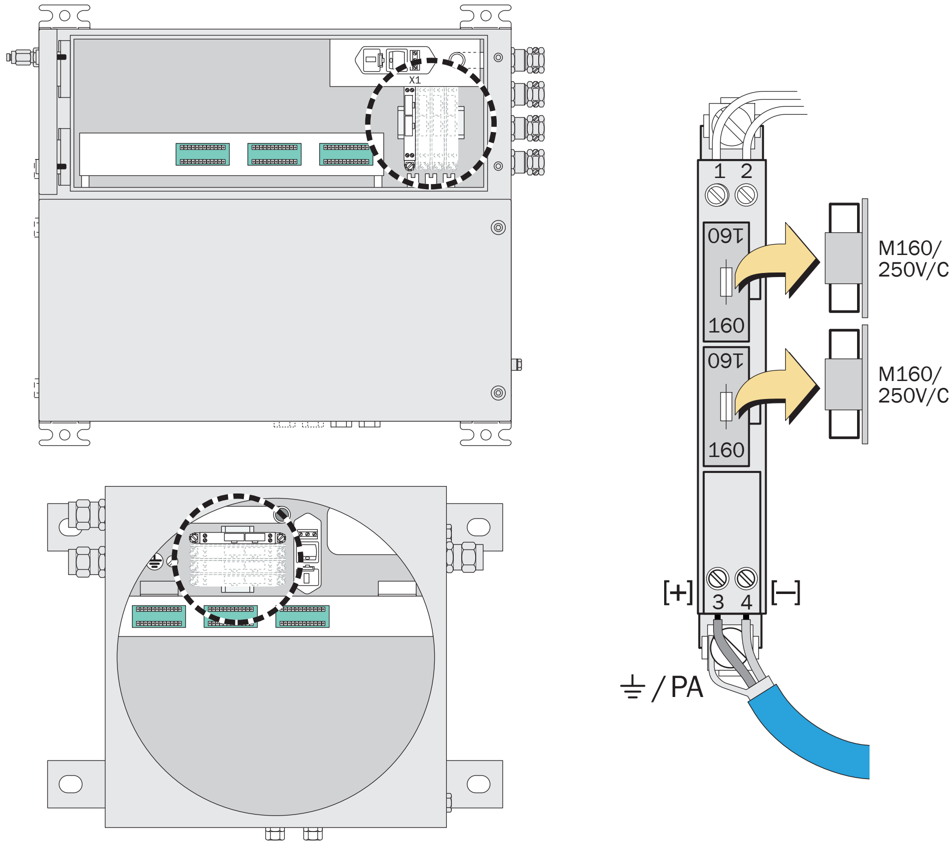
- ▶ Connect the signal cable to the module (see Fig. 17, page 64):

[+]	→	Terminal 3
[–]	→	Terminal 4
Shield	→	Terminal PA

- ▶ Install the signal cable in compliance with the European standard EN 50020:

WARNING: Risk of explosion
Intrinsically-safe installations must maintain a certain distance to non-intrinsic-safe devices (detailed specifications see EN 50020).
- ▶ Install cables of "intrinsic safety" circuits in such a way that the required distance to other electrical devices is always maintained.

Fig. 17: Intrinsically-safe measured value outputs



4.16 Digital interfaces

4.16.1 Function of the interfaces

- The S700 digital interfaces are serial interfaces (RS232C/V.24).
- Interface #1 can serve to use a remote control: The S700 receives commands and sends measuring results and status messages via the interface on command. This feature is available during operation
  - with the “limited AK protocol” option (see “Remote control with “AK protocol””, page 159)
  - with the Modbus remote control functions (see “Remote control with Modbus”, page 165).
- Interface #2 is used to send measuring and calibration data and status messages.

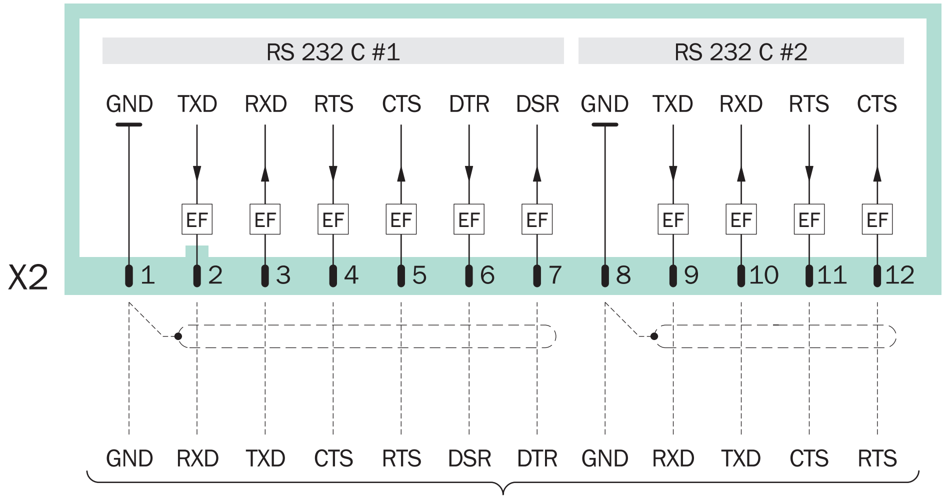
4.16.2 Connecting the interfaces

If you wish to use one of the interfaces:

1 Connect the external device to the relevant interface of the S700 (see Fig. 18, page 65; further information see “Creating an interface connection”, page 203).
2 Set the interface parameters of the S700 and the connected device so that they are identical (see “Digital interface parameters”, page 101).
3 *For interface #2:* Select whether the S700 should output certain data automatically (see “Output of digital measured data”, page 102).

- A serial interface can only work if the interface parameters of all connected instruments are identical.
- You can test the data output with a function (see “Testing electronic outputs (hardware test)”, page 121).

Fig. 18: Plug connector X2 (interfaces)



NOTE:
Maximum peak voltage for the digital interfaces = ±15 V

5 Start-up

5.1 Switch-on procedure

1. Check/prepare

▶ Make sure that the S700 is set-up for your mains voltage (see “Adapting to power voltage”, page 184).
▶ Make sure that the sample gas conditioning is working (see “Designing the sample gas feed”, page 37).

In potentially explosive atmospheres:

▶ Make sure that the enclosure is tightly closed (see “Closing the enclosure”, page 46).
▶ *S715 EX/S715 EX CSA – if the enclosure has been opened:* Perform a leak tightness check (see “Leak tightness check for the enclosure S715 EX”, page 178).
▶ Check the state of the connection cables.

2. Start-up

▶ Switch-on the external main power switch (see “Installing a separate disconnector switch”, page 50). – For S710/S711 alternatively/additionally: Switch-on the main power switch on the rear (see Fig. 7, page 51).

Automatic procedures after power-on:

● LED activities (when free from malfunctions and alarms):

LED	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
“Function”	red/green	red	red	red	green[1]
“Service”	on	on	on	off	off
“Alarm”	on	on	off	off	off

[1] when the operating temperature is reached and sample gas flow is established (gas pump on)

● The microprocessor system tests the S700 hardware. The display will show:

```
128 KB Ram & 1 MB Flash Memory ......
Real-Time Clock ....................
System Timers ......................
CPU Clock = 20.000 MHz .............
Processor: AM188ES Rev.:   B
Mainboard Version:    ..............
Startup-Code Version: xxxxxxx........
8 KB non-volatile Parameters RAM.....
Power-Supply Voltages & ADC .........
      --- Tests finished ---
```

If no fault is detected, then `OK` will appear at the end of each line.

● The microprocessor system tests the data memory integrity.
››› *If the test was error-free:* The measuring display appears (see “Measuring displays”, page 74).
››› *If an error was detected:* The microprocessor will automatically recover the state saved after the last calibration (see “Using an internal backup”, page 109), which makes the S700 operative again. Then the measuring display is shown and the warm-up time begins.

3. Wait for heating up time to complete

As long as the internal operating temperature is not reached, the LED "Function" will be *red* (at least for 2 minutes; status message: `Heating up`).

- ▶ Wait until the LED "Function" is *green*.
- ▶ Then wait another 2 hours for the internal temperature to stabilize.

4. Prepare the measuring operation

- ▶ see "Measurement preparation".

5.2 Measurement preparation

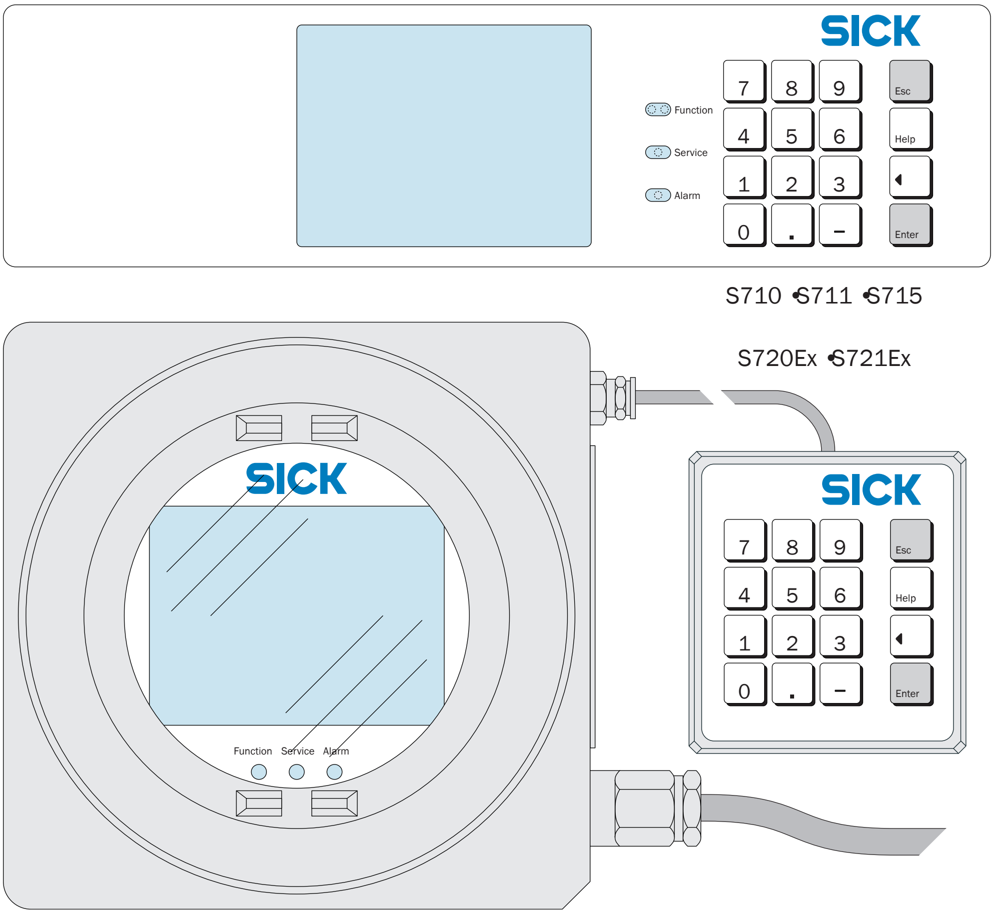
- ▶ *Before binding measurements are made:* Check the calibration of the S700 (see "Calibration", page 123). – Only a correctly calibrated analyzer produces correct measured values. Check the calibration even if you have a brand-new device.

CAUTION: Risk of wrong analysis
Without correct calibration, the measuring results might be wrong.
▶ Perform a new calibration whenever
- the S700 has been switched off for a longer time (for example, for more than 14 days)
- changes have been made to the S700 (for example, when sub-assemblies have been changed)
- something has been changed to the external installation (for example, the sample gas cooler)
- the S700 has been transported.

- ▶ *If the S700 has a fitted gas pump or an external sample gas pump or controls a corresponding solenoid valve (see "Configuration of the switching outputs", page 97):* Switch on the function `gas pump` (see "Switching the gas pump on/off", page 81).

6 Operation (general)

Fig. 19: *Operating and display elements*



6.1 LEDs

After power-on, all these LEDs are temporarily illuminated (see "Switch-on procedure", page 66).

Function (green/red)

- A *green* light indicates that the S700 is operationally ready and the measuring function can be started.
- A *red* light indicates that the S700 is not operationally ready. Possible causes:
  - After power-on, the operational temperature is not reached yet (see "Switch-on procedure", page 66).
  - The S700 has detected an internal fault (for example, defective electronics)
  - The measuring function is disturbed (for example, the sample gas flow or the internal temperature is too low).

  Function "red" corresponds to the status output signal "Fault" (see "Available switching functions", page 98). In most cases, the reason for the malfunction is indicated on the display (see "Status messages on the display").

Service (yellow)

If the “Service” LED is on during normal measuring operation, a problem is starting. The measuring function is not (yet) affected by this state, but a service technician should fix the problem soon. – In these cases, the “Service” LED corresponds to the status output signal “Service” (see “Available switching functions”, page 98).

The “Service” LED is also on

– when a calibration is running (+ a certain time afterwards, see “Setting test gas delay time”, page 138)
– when the menu branch `Service` is used (see “Main Menu”, page 73)
– as long as the maintenance signal is activated (see “Activating the maintenance signal”, page 84).

Alarm (red)

Is on when at least one measured value is beyond a programmed alarm limit value. In addition, the following message appears on the display (example):

`CO2    >    250.00 ppm`

(= “the current CO_2 value is greater than the alarm limit value of 250.00 ppm”).

- Setting alarm limit values, see “Setting alarm limit values”, page 91
- Programming the related switching outputs (see “Configuration of the switching outputs”, page 97)

6.2 Status messages on the display

On the second to last display line, the S700 shows a message

– when an internal limit value is exceeded (`SERVICE:` ...)
– when a faulty state or a fault is detected (`FAULT:` ...)
– when an operating state exists which affects the analysis.

If several status messages exist at the same time, then `CHECK STATUS/FAULTS` is displayed instead. The list of the all current status messages can be found under the `Status/Faults` menu (see “Display of status/malfunction messages”, page 77).

- Example of a status line, see “Principle of operation”, page 70
- Clarification of status messages, see “Status messages (in alphabetical order)”, page 186.

6.3 Principle of operation

6.3.1 Function selection

- For function selection, the display shows various “menus” with several selection options. The starting point is the `main menu` (see “Main Menu”, page 73).
- To select a particular function, press the related number key.
- Using the various menu functions, you can
  - enter parameters (for example, limit values for “Alarm” signals)
  - start routines (for example, calibration)
  - test device functions.
- If a measuring display was activated when the analyzer was shut off (see “Measuring displays”, page 74), then this display will be re-activated when it is switched on again. To call-up the `main menu`, press the [Esc] key twice.

6.3.2 Display of menu functions (example)

Display	Operating step/notes
`Device status 2`	← menu number and selected function
`1 status/faults`	← These ...
`2 measuring ranges`	← ←
`3 signal outputs`	← ←
`4 alarm limits`	← ←
`5 device data`	← ←
`6 absolute drift`	← ...are the possible selections in this menu
`Enter digit`	← operation note [1]
`Heating up ...`	← Status message (example; see “Status messages on the display”, page 69)
`CO2 492.15 ppm`	← current measured values [2]

[1] The operating information shows how to navigate further (here: Press a number key). To cancel a function, use the [Esc] key.
[2] Even during menu operations, the current status message (if there is one) and the current measured values are shown at the bottom line of the display.

6.3.3 Keypad functions

Next to the numerical keys (numbers 0 to 9, decimal point, minus key), there are four function keys for the S700:

Key	Meaning	Function
Esc	Escape	Ends the displayed function and returns to the preceding menu, without changing the device status. Pressing [Esc] several times leads back to the main menu.
Help	Help	Provides with information on the menu or function which is currently displayed.
◀	Backspace	Deletes the last digit of the current entry.
Enter	Enter	Enters the input or displayed value and stores it as the new value.

- In many of the input procedures, the currently stored value is shown after `Status`. When you have entered a new value, press [Enter] to store this new value.
- The S700 can give an acoustic signal on each keypad entry. The tone intensity is adjustable (see “Setting the keypad click”, page 83).
- Even during menu operation, the S700 is permanently analyzing. This is why the S700 may sometimes react a little slow to a keypad entry.

If you wish to learn about the operating functions, you can call-up menus and [Help] texts as you like. As long as you don’t press the [Enter] key in an input menu, you will not change any of the settings.

6.3.4 Menu levels

The S700 menu functions are sub-divided into “menu levels”:

- Standard functions
- Expert functions
- Hidden expert functions
- Factory settings

Standard functions

are categorised as the operating functions, necessary for routine operations of the S700. With this group of functions you can:

- check the device status on the display
- switch the sample pump on and off
- activate a status output to signal that maintenance work is currently in progress
- start or run a calibration

Description of these functions, see “Standard functions”, page 73.

Expert functions

are used for setting device parameters and for device testing. They are only available after pressing a certain key (see “Access to the expert functions”, page 85). With this group of functions you can for example:

- set the limit values for “Alarm” signaling
- set the power of the built-in gas pump (option)
- set the communication parameters of the digital interfaces
- set-up the automatic calibration routine
- enter the nominal values of the calibration gases
- test all of the inputs and outputs

Some advanced expert functions are only available after entering a certain code (see “Access to the expert functions”, page 85). With this group of functions you can, for example:

- assign a switching function to each of the configurable signal connections
- influence how the measured value output works
- save all of the settings and restore previous settings

Description of the expert functions, see “Expert functions”, page 85.

+i
- You should only use the expert functions when you are completely familiar with the effects of the function settings and you understand the procedures.
- If a switching output with the function “service block” has been activated, then many of the menu functions cannot be used (see “Available control functions”, page 99).

Factory settings

In the “factory settings” menu, factory-trained technicians can change basic device settings. Access to this group of functions is not shown in the menus and they are only accessible with a pass code.

The factory settings are not described in this Instruction Manual.

7 Standard functions

7.1 Main Menu

Main menu	
1 measuring display	← standard functions
2 device status	←
3 control	←
4 calibration	←
5 maintenance signal	←
6 settings	← expert functions [1]
7 service	←
Enter digit	← operation information
No messages	← status messages
CO 12 mg/m3	← measured values (alternating)

[1] see “Expert functions”, page 85

7.2 Measuring displays

7.2.1 Combined display for all components

Function

This type of display allows you to see all current measured values at the same time.

Call-up

▶ Select `main menu→ measuring display → all components`.

The following appears on the display (example):

#2	← current sampling point [1]
CO	← bargraph display [2]
12 mg/m3	← current measured value [3]
COCl2	
25 mg/m3	
CH, H2	
52 mg/m3	
NOx	
8 mg/m3	
Math	
77 mg/m3	
Selection: ESCAPE	← *To exit this display:* Press [Esc].

[1] Only shown when the sampling point selector is activated (option; see "Sampling point selector (option)", page 119.

[2] Symbolizes the magnitude of current measured value, either in relation to the measuring range or to the output range (selection see "Bar graph range selection", page 87).

[3] Possibly the measured values are displayed more accurate than the specified measuring precision would allow (see "Select number of decimal places", page 87).

- The display contrast is adjustable (see "Setting the display contrast", page 83).
- When a measured value exceeds the internal calculation limits, then the S700 will display a malfunction message. This feature can be disabled (see "Activating warnings of working range limits (overflow warnings)", page 92).

+i It is possible that a measuring component represents the measured value of another device, or a value calculated from an external measuring signal (see "Analog inputs", page 58).

7.2.2 Large display for one selected component

Function

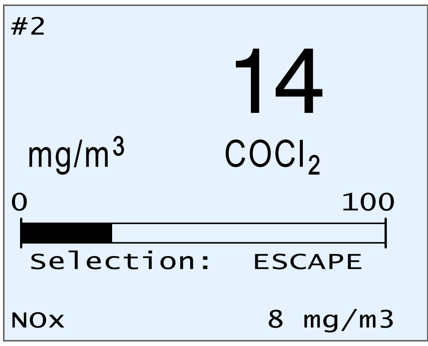
You can select a large version of the measuring display for just one particular measuring component – for example, if you would like to watch this measured value more closely. The measured values for the other components are displayed in the bottom text line.

> It is possible that a measuring component represents the measured value of another device, or a value calculated from an external measuring signal (see "Analog inputs", page 58).

Call-up

1 Select `main menu → measuring display`
2 Select the desired measuring component.

The following should appear on the display (example):



- ← current sampling point [1]
- ← current measured value [2]
- ← units of measurement, measuring component
- ← end value of the physical measuring range [3]
- ← bargraph display [4]
- ← *To exit this display:* Press [Esc].
- ← other measured values (shown sequentially)

[1] Only shown when the sampling point selector is activated (option; see "Sampling point selector (option)", page 119.
[2] Possibly the measured value is displayed more accurate than the specified measuring precision would allow (see "Select number of decimal places", page 87).
[3] The S700 displays measured values which exceed the maximum values within limits, however, the precision of these measured values is not known.
[4] Symbolises the magnitude of current measured value, either in relation to the measuring range or to the output range (selection see "Bar graph range selection", page 87).

7.2.3 Chart recorder simulation

Function

The S700 can graphically show the trend of the measured values. This functions the same way as on paper in a chart recorder: Current sampling points appear at the top and "wander" slowly downwards. In this way you can continuously monitor the trend of the measured values. The time scale is adjustable from 1 to 32 hours. The value range corresponds to the current output range.

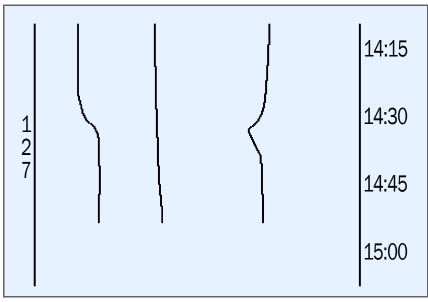
In addition, you can have the analyzer display the following values:

- Signal of analog input IN1 (see "Analog inputs", page 58)
- Temperature inside the S700 (numerical display, see "Status of the internal controller", page 116)
- Sample gas pressure / atmospheric pressure (numerical display, see "Signals of the internal sensors and analog inputs", page 116)

Call-up

1 Select `main menu → measuring display → chart recorder`.

Then a display like this is shown:



← top: current sampling points [1]
←
← bottom: previous sampling points
←
←

[1] Start of the range = left

- If you do not see any measuring line, there are possibly no previous measured values available to display. Try selecting the smallest time interval (see below) and wait for a few minutes.
- Moreover, you might not see “lively” chart lines when the measured values are constant (for example, when they are “0”), or when they are identical, or if there are no measured values activated to display.

2 Using the keypad, select which measured values should be displayed:

Key	toggles the display for the ...
[1]	measured value of the measuring component assigned to output OUT1
[2]	measured value of the measuring component assigned to output OUT2 [1] [2]
[3]	measured value of the measuring component assigned to output OUT3 [1] [2]
[4]	measured value of the measuring component assigned to output OUT4 [1] [2]
[5]	measured value of the fifth meas. component (not assigned to any output) [1]
[6]	internal temperature (0 ... 100 °C)
[7]	measured value for the built-in pressure sensor (900 ... 1100 hPa)
[8]	analog input signal IN1 (0 ... 5 V)
[9]	all values [1] ... [8]
[0]	no values

[1] if available
[2] If a measuring component is assigned more than once, only *one* line will be displayed

3 Select the desired time interval to be displayed:

Key	Effect
[Enter]	Toggles the time interval in steps: 1/32/16/8/4/2/1/32/... hours
[.]	shifts the time interval 25 % towards the past
[-]	shifts the interval 25 % towards the present [1]
[<]	resets to default setting (starting time = present, interval = 1 hour)

[1] if the interval was previously shifted towards the past

- These functions are also explained when you select the on-line [Help].
- If you want to determine which lines represent which values then try switching single values on and off.

4 To exit this display, press [Esc].

7.3 Status displays

7.3.1 Display of status/malfunction messages

Function

Call-up `device status` - `Status/error` to display all current malfunction and status messages of the S700.

Call-up

▶ Select `main menu` → `device status` → `status/fault`.

`status/faults`	
`Heating up ...`	← The current status messages ...
`FAULT: condensate`	←
	←
	←
	←
	← ... are shown here [1]
`Back : ESCAPE`	*To exit this display:* Press [Esc].

[1] Clarification (in alphabetical order), see "Status messages (in alphabetical order)", page 186

7.3.2 Display of measuring ranges

Function

Using the menu `device status` - `measuring ranges`, you can see the physical measuring ranges. These settings can only be changed at the factory.

Call-up

1 Select `main menu` → `device status` → `measuring ranges`.
2 Select the desired measuring component.

`Measuring ranges`	
`H2 80.00 vol.%`	← start value of the physical measuring range
`to 100.00 vol.%`	← end value of the physical measuring range
`Span gas`	
`100.00 vol.%`	← physical zero point of the related analyzer module
`Back : ESCAPE`	*To exit this display:* Press [Esc].

- To display the output ranges of the measured value outputs, see "Display of measured value outputs", page 78.
- To set the output ranges, see "Setting-up the output ranges", page 94.

7.3.3 Display of measured value outputs

Function

The `device status - meas. value outputs` display shows which measured values are output via the analog outputs and which output ranges are set-up.

Call-up

1 Select `main menu → device status → meas. value outputs`.
2 Select the desired `meas. value output`.

`Measured value output 1`	← meas. value output number
`O2`	← assigned measuring component
`4...20 mA`	← electrical measuring span (output span)
`0.00 - 25.00 vol.%`	← physical meas. range of the meas. component.
`[1] 0.00 - 10.00`	← start and end value for output range 1
`Switch pt.: 10.00`	← switching pt. for auto. range switching 1 → 2
`[2] 0.00 - 25.00`	← start and end value for output range 2
`Switch pt.: 9.50`	← switching pt. for auto. range switching 2 → 1
`active 2`	← current output range
`Back : ESCAPE`	*To exit this display:* Press [Esc].

- Assignment of the measuring components, see “Assigning measuring components”, page 93.
- To set the output ranges, see “Setting-up the output ranges”, page 94.

7.3.4 Display of alarm limit values

Function

The function `device status - alarm settings` displays the alarm settings set (see “Setting alarm limit values”, page 91).

Call-up

▶ Select `main menu → device status → alarm settings`.

`Alarm settings`	
`component ef value`	
`[1] CO2 > 360.00`	← [...] = alarm number
`[2] O2 < 12.75`	← “<” = alarm is given below the limit value
`[3] CO2 > 250.00`	← “>” = alarm is given above the limit value
`[4] Not in use !`	← this alarm limit value is not defined
`Back : ESCAPE`	*To exit this display:* Press [Esc].

7.3.5 Display of device data

Function

The menu `device data` provides the following information:

- individual device identification
- version of internal hardware and software
- built-in analyzer modules

Call-up

▶ Select `main menu` → `device status` → `device data`.

device data	
device name:	
S710	← stored device name
Device no.:	
123456	← serial number
hardware version: 1	← electronic board version in your analyzer
software version:1.28	← version of the software in your analyzer
sensor type 1-3	
MULTOR	← built-in analyzer module (example)
OXOR	← built-in analyzer module (example)
Back: ESCAPE	*To exit this display:* Press [Esc].

7.3.6 Display of drift values

Function

The “absolute drifts” represent the total drift over a number of calibrations (thus they do not represent the difference between the last two calibrations).

A new summation of “absolute drifts” will be started

– after a drift reset (see “Drift reset”, page 143)
– after a basic calibration (see “Basic calibration”, page 145).

> +i
> - After a drift reset or a basic calibration, there are no absolute drifts until a new calibration has been made.
> - This also applies to brand-new analyzers where absolute drifts will not appear before a calibration has been made.

“Absolute drifts” refer to the displayed measured values (including linearisation, drift compensation, etc.). Zero point drifts are related to the physical measuring span of the relative analyzer module; sensitivity drifts are relative to the nominal value of the test gas used during calibration. Notes on the calculation, see “Displaying calibration data”, page 142.

Call-up

► Select `main menu→ device status→ absolute drift`.

`absolute drifts`	
	←
`zero-d   span-d`	← “zero point drift” / “sensitivity drift”
`O2    0.2%   -2.3%`	← (example values)
`CO2  -1.0%   -1.6%`	←
`NO   -0.7%    0.3%`	←
`Back    :  ESCAPE`	*To exit this display:* Press [Esc].

7.4 Control

7.4.1 Switching the gas pump on/off

Function

This function is used to switch the fitted gas pump (option) and the switching output "external pump" on and off (see "Available switching functions", page 98).

> The gas pump will automatically remain switched off
> - as long as the S700 has not reached its operating temperature
> - as long as the fitted condensate sensor (option) triggers;
> - when calibration gas is fed, if this is set (see "Setting the nominal values for the calibration gases", page 136);
> - if the control input "gas pump off" is set-up and activated (see "Available control functions", page 99).

Setting

▶ Select `main menu→ control → gas pump on/off`.

`gas pump on/off`
 	
`Selection:   0=OFF`
`             1=ON`
 	
`Status    :   OFF`
 	
`Input     : ■ OFF`
 	
`Save      : ENTER`
`Back      : ESCAPE`
	To change the status:
	1 Enter either [0] or [1].
	2 Press [Enter].
	3 Press [Esc] to exit this function without any (more) changes.

> This menu function is not available when a "service block" control input is set-up and activated (see "Available control functions", page 99).

7.4.2 Acknowledging alarms

Function

For safety purposes, some status messages will remain activated even when the initial reason for the message does not exist any more. This applies to:

- the malfunction message of the condensate sensor (option);
- "Alarm" messages, if this characteristic is activated (see "Setting alarm limit values", page 91).

Notes on the "condensate" malfunction message

A S700 with fitted condensate sensor (option) signals `ERROR: condensate`, when condensate occurs in the internal sample gas path or when a conductive liquid enters the sample gas path of the S700.

It is possible that the condensate is only present for a short time, and after a while the condensate sensor is "dry" again. However, some components of the S700 measuring system might have been damaged by the condensate. This malfunction should always be checked. This is why the S700 does not automatically cancel the message `FAULT: condensate` even if the condensate sensor no longer signals a fault state.

Damage through liquids and corrosion

- When the S700 indicates `FAULT: condensate`, please first locate and repair the source of the problem (see page 187).
- Then switch off the fault signal.

Procedure

1 Select `main menu→ control → acknowledge`.

››› The status messages which need to be acknowledged will be displayed. There is a code above each status message. A code letter identifies the current status:

Table 8: Code letters for status messages which must be acknowledged

Code	The cause for the status message is ...	The status message is currently ...
–	currently not present	not activated
A	actively present	activated (not acknowledged)
N	currently not present	activated (not acknowledged)
Q	actively present	acknowledged and deactivated

Analyzers with the "sampling point selector" option (see page 119) will display these codes in a Table. This Table represents the sampling points. You can see which sampling point has caused the status message.

To acknowledge a status message:

2 Enter the desired code.

3 Press [Enter].

7.4.3 Setting the display contrast

Function

However, the display setting allows you to adjust the visual impression. Just try which setting is best for your location.

Setting

Select `main menu` → `control` → `display`.

`Display`
 	
`Unit: value`
`Min. value: 0`
`Max. value: 9`
 	
`Status: 7`
 	
`Input: ■`
`Back: ESCAPE`
	▸ *to change the display contrast:* Select a number key. The display contrast will immediately change.
	▸ To save the value, press [Enter].
	▸ To exit this function, press [Esc].

If a “service block” control input is set-up and activated (see “Available control functions”, page 99), then this menu is not available.

7.4.4 Setting the keypad click

Function

The S700 can give an acoustic signal on each keypad entry. The length of the tone is adjustable, which allows you to adjust the intensity. To disable the key click, set the status value to “0”.

Setting

Select `main menu` → `control` → `keypad click`.

`keypad click`
 	
`Unit: value`
`Min. value: 0`
`Max. value: 20`
 	
`Status: 7`
 	
`Input: ■`
`Back: ESCAPE`
	▸ *To change the status:* Enter the desired value and press [Enter].
	▸ To exit this function, press [Esc].

This menu function is not available when a “service block” control input is set-up and activated (see “Available control functions”, page 99).

7.5 Calibration (note)

The `calibration` function allows you to

- start or perform calibration procedures
- check the stored calibration parameters
- check the starting time of the next automatic calibration (if set).

All these functions are explained in a separate chapter (see “Calibration”, page 123).

7.6 Activating the maintenance signal

Function

The status output “service” (see “Available switching functions”, page 98) can also be activated from per menu function. This can be used as a signal message to an external place to indicate that the S700 is not working in regular measuring mode; for example, because maintenance is currently being carried out.

Setting

`Main menu`
 	
`1 measuring display`
`2 device status`
`3 control`
`4 calibration`
`5 maintenance signal`
	1 *If the* `main menu` *is not displayed:* Press [Esc] repeatedly until the `main menu` appears.
	
	2 Select `maintenance signal`.

`Maintenance signal`
 	
`Selection: 0=OFF`
`           1=ON`
 	
`Status    :   OFF`
 	
`Input     : ■ OFF`
 	
`Save      : ENTER`
`Back      : ESCAPE`
	▸ *To change the status:* Enter “0” or “1” and press [Enter].
	
	▸ *To exit this function without any (more) changes:* Press [Esc].

+i

- This menu function is not available when a “service block” control input is set-up and activated. This menu function can also be interrupted/cancelled by switching the “service block” (see “Available control functions”, page 99).
- Please do not forget to switch off the maintenance signal when it is no longer required.

8 Expert functions

8.1 Access to the expert functions

Do the following to access the expert functions:

Display	*Operation step / notes*
Any menu	▶ Press [Esc] as often as required until the `main menu` is displayed.

`Main menu`
 	
`1 measuring display`
`2 device status`
`3 control`
`4 calibration`
`5 maintenance signal`
	▶ Press the decimal point key [.]
	After that ...

`Main menu`
 	
`1 measuring display`
`2 device status`
`3 control`
`4 calibration`
`5 maintenance signal`
`6 settings`
`7 service`
	... the menu items 6 and 7 are available.
	
	▶ *To fade out the expert functions:* Press the decimal point key [.] again.

When you call-up `settings` or `service`, a warning message is displayed:

▶ Read the warning message and consider it.
▶ Press [Enter] to proceed.

> If a "service block" control input is set-up and activated, then only the menu items `1` and `2` are available in the `main menu` (see "Available control functions", page 99).

8.2 Hidden expert functions

Some of the expert functions are located in menu branch 69. However, menu item 9 is not shown in the `settings` menu. To access the expert functions in menu branch 69:

1 Call up the `settings` menu (see "Access to the expert functions").
2 Press the [9] key.
3 Enter this `Code`: [7] [2] [7] [5] [Enter]

After that, menu 69 is displayed, with all its functions available.

8.3 Local adaptation (localization)

8.3.1 Language setting

Function

Each S700 can display the menu texts and the “Help” information in different languages. You can change the language at any time. Call-up the selection menu to see the languages available.

Setting

1 Call-up menu 66 (`main menu → settings → language`).
2 Select the desired language from the displayed list.

8.3.2 Setting the internal clock

Time

1 Call-up menu 611 (`main menu → settings → clock → time`).
2 Enter the current time and press [Enter]. When you press the key, the internal clock starts with the entered time and `:00` seconds.

Please also check the summer time/standard time setting.

Date

1 Call-up menu 612 (`main menu → settings → clock → date`).
2 Enter the current date and press [Enter].

Summer time or standard time

1 Call-up menu 613 (`main menu → settings → clock → std./summer time`).
2 Select `standard time` or `summer time` and press [Enter].

With summer time, the clock is set one hour forwards. – Example: Std. time 18:00 = summer time 19:00.

Time format

The internal clock can be set to display either in European 24-hour format (`00.00` to `23.59`) or in American `am/pm` format.

1 Call-up menu 614 (`main menu → settings → clock → time format`).
2 Input the desired setting and press [Enter].

Date format

The date can be displayed in European format (day.month.year) or in American format (month-day-year).

1 Call-up menu 615 (`main menu → settings → clock → date format`).
2 Input the desired setting and press [Enter].

8.4 Display of measured values

8.4.1 Select number of decimal places

Function

A maximum of five characters can be used to display a measured value. If the measured value includes decimal places, you can select the desired number of decimals. The selection range depends on the number format of the physical measuring range end value.

- If the measured value display includes 4 or 5 characters, then the measured value display is more accurate than the real measuring precision. Moreover, the last digits might permanently fluctuate even when the measured value should be seen as constant (within the limits of the measuring precision/signal “noise”). This effect can be influenced by “damping” (see “Setting damping (rolling average value computa-tion)”, page 88).
- If you limit the number of decimal places so that the measured value display only contains 2 or 3 numbers, then you might possibly not be able to notice slow measured value shifts in time.

Setting

1 Call-up menu 623 (`main menu→ settings → measurement → meas. value display.`).
2 Select which measuring component the setting should be made for.
3 Select `decimal places`.
4 Set the desired number of decimal places (select anywhere between `min.value` / `max.value`).

8.4.2 Bar graph range selection

Function

You can select if the “bargraph” display (see “Measuring displays”, page 74) represents the physical measuring range of the related measuring component or if it represents the current output range of the associated measured value output (see “Selecting the output ranges”, page 95).

Setting

1 Call up menu 623 (`main menu → settings → measurement → meas. value display`).
2 Select which measuring component the setting should be made for.
3 Select `bargraph range`.
4 Select `phys. meas. range` or `output range`.

8.5 Measured value computation

8.5.1 Setting damping (rolling average value computation)

Function

The S700 updates the measured value displays and outputs in periods of approx. 0.5 to 20 seconds. In some applications, this may cause some problems:

- Rapid changes in the gas concentration will cause “leaps” between the generated measured values.
- If the current gas concentration fluctuates around an average value, this will produce many different measured values. However, you may want to see the average value.

You can reduce these effects by setting a “damping” value. When you set-up this, the S700 will not display the current measured values, but averages of the current and the previous values (floating averaging).

- You can set the damping for each measuring component individually, e.g in order to optimise the setting for each analyzer module.
- The damping effects both the display and the measured value output signal.
- The damping is also effective during calibration.

> - Increasing the damping value will probably increase the total response time (90% time) of the gas analysis system.
> - Decreasing the damping can increase the “noise” of the measuring signal (measuring turbulence).
> - The response time of the gas analyzer also depends on factors related to the gas feed (i.e. length of the sample gas path, volume of filter vessels, etc.). Therefore, it cannot be reduced at random.

> If you need to compensate for measured value fluctuations without increasing the response time significantly, try the “dynamic damping” (see “Setting dynamic damping”, page 89).

Setting

CAUTION: Risk for connected devices/systems
If the damping is changed during measuring operation, it might occur that the measured values make a rapid change at once.
▶ Make sure that this situation cannot cause problems on connected devices.

1 Call-up menu 624 (`main menu → settings → measurement → damping`).
2 Select which measuring component the setting should be made for.
3 Set the desired time constant.

CAUTION: Risk of wrong calibration
The calibration measuring time should be at least 150 ... 200 % of the programmed damping time constant.
▶ *When the damping has been set anew or increased:* Check whether the calibration measuring interval needs to be adjusted (see “Setting the calibration measuring interval”, page 139).

8.5.2 Setting dynamic damping

Function

Contrary to normal damping (see page 88), “dynamic damping” is automatically deactivated when the measured value changes rapidly. This allows you to “smooth out” continuous *minor* fluctuations of the measured value, while having an instant response when the measured value is *rapidly* changing.

This dynamic behavior is controlled with the response threshold: With dynamic damping, the S700 continuously checks the difference between two consecutive measured values from the internal measured value processing; dynamic damping is then deactivated when the difference is larger than the response threshold. The result is:

– If the differences *continue* to be greater than the response threshold (which means that the measured values are still changing rapidly), the dynamic damping will fade out – after the selected damping time constant has run down, the damping effect is completely off and does not slow down the response time any longer.
– As soon as the differences of the measured value come down and remain below the response threshold (which means that the measured value changes are small and slow), the dynamic damping will gradually come back into operation.

Functional features

- The time constant of the damping and the response threshold are individually adjustable for each measuring component.
- The response threshold is always relative to the measuring span of the current output range of the corresponding measured value output.
- The dynamic damping effects the measured value output signal and the displayed measured values.
- Dynamic damping is also effective during calibration.

Setting the time constant

1 Call up menu 6971 (`main menu → settings → [9] → [code] → dyn. damping → time constant`).
2 Select which measuring component the setting should be made for.
3 Set the desired time constant (1 ... 120 s).

Setting the response threshold

1 Call-up menu 6972 (`main menu → settings → [9] → [code] → dyn. damping → dyn. threshold`).
2 Select which measuring component the setting should be made for.
3 Set the desired threshold value. – Setting range: 0.0 ... 10.0 % of the measurement span of the output range. 0.0 = dynamic damping off (de-selected).

CAUTION: Risk of wrong calibration
The calibration measuring time should be at least 150 ... 200 % of the programmed damping time constant.
▶ *When the damping has been set anew or increased:* Check whether the calibration measuring interval needs to be adjusted (see page 139).

8.5.3 Suppressing measured values at the start of the measuring range

Function

You can force all measured values close to the start value of the physical measuring range to be displayed as “ 0 ” (or as the respective measuring range start value). This would “mask” measuring fluctuations at the zero point. You could use this feature, for example, to suppress the display of negative measured values, or if the measured values are passed to an external control unit, to “turn down” the control to zero in case of very small measured values. You can set-up this feature

- separately for a range above and below the physical start value of the range
- individually for each measuring component

The possible “masking” range is 10 % of the physical measuring range. Masked ranges are effective for all measured value indications concerned, i.e. for

- measured values shown on the display
- measured value output signals
- digital measured value outputs via interface

CAUTION: Possible effects on connected devices

- *With measured value masks:* The measured value displayed does not usually match the actual measured value in masked out display ranges. As soon as the true measured value leaves the masked range, the displayed measured values will suddenly change from the “masked” to the current measured value. A similar effect will happen in reverse direction. If an external controller is connected, these effects should be considered.
- *Without measured value masks:* The measured value display follows the measuring signals consequently even at the start of the physical measuring range. Due to the limited measuring precision, also small *negative* measured values could be displayed. (This does not apply to the analog measured value outputs which cannot produce negative signals.)

▶ Consider the effect of measuring signal masks on connected devices.

Setting

1. Call-up menu 692 (`main menu` → `settings` → `[9]` → [code] → `meas. sig. window`).
2. Select the `meas. component` for which this following settings should apply.
3. Select `neg. window` or `pos. window`.
4. Set the end value of the masked range. (The start value of the masked range is identical to the start value of the physical measuring range).

8.6 Monitoring measured values

8.6.1 Setting alarm limit values

Function

You can set four limit values to monitor the measured values. The associated “Alarm” signal can be triggered when the measured value is above or below the limit value. You can also decide if the “Alarm” signal remains activated even when the measured value is no longer beyond the limit value, until the “Alarm” signal is manually “acknowledged” (see “Acknowledging alarms”, page 82).

When the measured value exceeds a programmed limit value

- the LED “Alarm” on the front of the S700 is illuminated;
- a message appears on the display, e.g.. `CO2 > 250.00 ppm`;
- the related “Alarm” status output is activated (see “Available switching functions”, page 98) .

For an overview over all set alarm setting, see `main menu → device status → alarm settings`.

Setting

1 Call-up menu 622 (`main menu → settings → measurement → alarm settings`).
2 Select the desired `alarm limit value (1` ... 4).
3 Make the following settings:

`Meas. component`	The measuring component for which the following settings will be valid
`Set point`	Limit value in physical (engineering) units

`Effect`	`exceeds set pt.` = “Alarm” will be given when the measured value is larger than the `set point`
	`under set pt.` = “Alarm” will be given when the measured value is smaller than the `set point`
	`off` = the limit value is deactivated (settings are kept, but have no effect)

`Acknowledge`	`off`= the “Alarm” message disappears as soon as the measured value is no longer beyond the set point. `on`= the “Alarm” message remains until the signal is manually “acknowledged” (see “Acknowledging alarms”, page 82)

8.6.2 Activating warnings of working range limits (overflow warnings)

Function

The S700 will create a malfunction message

- when a measured value is larger than 120 % of the end value of the related physical measuring range;
- when an internal measuring signal exceeds the limits of the internal measured value processing.

Connected devices could consider this status message as a failure of the gas analyzer. In this case, the gas analyzer would appear as if failed even though it is functioning perfectly and the real reason is the high measured values. To avoid this wrong interpretation, you can disable these automatic malfunction messages.

Procedure

1 Call-up menu 693 (`main menu` → `settings` → `[9]` → [code] → `meas. signal effect`).
2 Select the desired function:

`no over range al.`	... refers to the malfunction message created when a measured value exceeds 120 % of the physical measuring range (measured value warning)
`no overflow alarm`	... refers to the malfunction message created when a measured value exceeds the internal processing range (overflow warning)

3 Now select the desired mode for this function:

OFF	automatic warning is activated (= standard setting)
ON	automatic warning is deactivated

8.7 Configuring calibration (note)

For information on menu branch 63 (`main menu` → `settings` → `calibration`) please refer to see “Automatic calibration”, page 133.

8.8 Configuration of measured value outputs

> A measured value output must be assigned to a particular measuring component before you can make all the other associated settings.

8.8.1 Special functions for certain sampling point configurations

If the S700

– is equipped with the option “sampling point selector” (see page 119)
– *and* measures only one measuring component
– *and* the number of sampling points has been set to 1, 2, 3 or 4

then

- each measured value output will automatically represent one of the sampling points and will constantly display the last measured value of its assigned sampling point, as long as the other sampling points are measured (“sample-hold” function)
- settings for measured value output 1 are automatically valid for the remaining measured value outputs; deviating settings for measured value outputs 2, 3 and 4 are not possible.

In all other cases, the measured value output will constantly display the current measured value of its assigned measuring component.

8.8.2 Assigning measuring components

Function

Each measured value output can be assigned to one of the measuring components. You can also assign one certain measuring component to several measured value outputs.

Notice: To change an existing assignment, first delete the remaining settings of the related measured value output. Otherwise your selection would have no effect.

Setting

1. *to change an existing assignment:* Delete all the settings for the related measured value output (see page 96).
2. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
3. Select the desired `meas. value output`.
4. Call-up `meas. component`.
5. Select the desired measuring component from the available list.
   The selected component is indicated by `>`.

8.8.3 Setting-up the output ranges

Function

The output ranges for the measured value outputs have been set-up at the factory, but they can be modified.

With the option “second output range”, each measured value output can have two output ranges which can be independently set. Please note:

- The difference between the start and end value of an output range must be at least 10 % of the physical measuring range end value. This limitation is automatically set in the related setting menus.
- The output ranges must logically overlap. A “gap” between the output ranges is not allowed.
- These settings can not change the physical measuring range.
- Output range 2 should correspond to the physical measuring range.

Setting

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2. Select the desired `meas. value output`.
3. Select `output range 1` or `output range 2`.
4. Set the following values:

`begin value`	Physical start value for this output range
`end value`	Physical end value for this output range
`switching point` [1]	`switch-up value` = the measured value where the analyzer should switch from output range 1 to output range 2. Usually this is the same value as the end value of this output range. But you can also select any value within the displayed `Min./Max.` range.
	`switch-down value` = the measured value where the analyzer should switch from output range 2 to output range 1. The `switch-down value` must be *`smaller`* than the switch-up value. Set-up this value in such a way that the difference between the `switch-up value` and the `switch-down value` is significantly larger than the specified measuring precision of the S700.

[1] only for analyzers equipped with the option “second output range”

▶ Do not set-up identical switching points.
Otherwise the S700 would permanently be switching between the output ranges when the measured value is at the switching point.

- Standard value for the difference in switching points:
  2 % of the relevant physical measuring range.
- Set-up a greater difference between the switching points if the measured values can be expected to be fluctuating or “noisy”.

8.8.4 Display of output ranges

To display the output ranges for each measured value output:

1. Call-up menu 621(`main menu → settings → measurement → meas. value outputs`).
2. Select the desired `meas. value output`.
3. Call-up `output range list`.

8.8.5 Selecting the output ranges

This function is only available with the option "second output range".

Function

There are three modes of output range selection for each measured value output:

- Fixed setting of the desired output range
- Internal automatic range switching (switching points, see "Setting-up the output ranges", page 94)
- External range control via control input (see "Available control functions", page 99)

Setting

1. Call-up menu 621 (`main menu → settings → measurement → meas. value outputs`).
2. Select the desired `meas. value output`.
3. Call-up `range selection`.
4. Select the desired mode:

`Output range 1`	Output range is fixed
`Output range 2`	
`auto. switching`	Internal automatic range switching
`ext. switching`	External range selection via control input

+i
- The numerical measured value display on the display will not be affected by the output range selection.
- The bar graph display of the measured values can be set-up to represent either the physical measuring range or the current output range (see "Bar graph range selection", page 87).

8.8.6 Setting the "live zero"/deactivating a measured value output

Function

Each measured value output can be programmed to represent the measured values within the range 0 ... 20 mA, 2 ... 20 mA, or 4 ... 20 mA. When a "live zero" is selected (2 mA or 4 mA), the electronic signal "0 mA" can be interpreted as an general fault condition or electrical disconnection.

You can also deactivate each measured value output: The measured value output remains at "0 mA" in this case.

Setting

1. Call-up menu 621 (`main menu → settings → measurement→ meas. value outputs`).
2. Select the desired `meas. value output`.
3. Call-up `live zero (mA)`.
4. Select the desired electrical zero point for this measured value output or select `no output`.

8.8.7 Selecting the output mode during calibration

Function

During a calibration, the measured value outputs can function in two different modes:

- constant output of the measured value that was last measured before the calibration started (in the last selected output range); or
- The measured value output outputs the measuring signals which are generated during feeding of test gas. In this mode, the measured value output displays “raw values” without any compensation; thus, the calibration gas values can be registered in a “raw state” to determine the “absolute drift”. The measured values shown on the display do not exactly correspond to these output signals.

Setting

1 Call-up menu 621 (`main menu` → `settings` → `measurement` → `meas. value outputs`).
2 Select the desired `meas. value output`.
3 Call-up `output assignment`.
4 Select the desired mode during calibration:

`Calibr. value`	Output of current calibration gas values (output range 2)
`hold meas. value`	Constant output of the last measured value

8.8.8 Deleting the setting for a measured value output

Function

This menu allows to delete all of the settings for a measured value output. After you have deleted the settings, the measured value output will constantly display 0 % (0 mA).

For a short-time shut off of a measured value output, set “no output” for the live zero (see “Setting the “live zero”/deactivating a measured value output”, page 95). In this way, all the other measured value output settings would be kept.

Setting

1 Call-up menu 621 (`main menu` → `settings` → `measurement` → `meas. value outputs`).
2 Select the desired `meas. value output`.
3 Call-up `delete config.`

8.9 Configuration of the switching outputs

8.9.1 Functional principle

You can assign each of the configurable switching outputs (REL4 ... REL8 and TR1 ... TR8 see “Switching outputs”, page 59) to any of the available control functions (see “Available switching functions”, page 98).

> You can assign the same control function to multiple switching outputs – for example, if you need two separate switch contacts for the same operation.

8.9.2 Control logic

Switch logic (make contact / break contact)

The relay switch contacts allow you to connect the external switching function to a make contact or a break contact. Use this feature in combination with the activation logic to find the appropriate control logic for your system.

Activation logic (open-circuit/closed-circuit principle)

Once you have assigned a control function to a switching output, you have two possibilities:

- *Normal switching logic (open-circuit principle):* In this case, the switching output is electronically activated (relay activated, transistor output conducts current) when the assigned switching function is logically in the activated state.
- *Reversed switching logic (closed-circuit principle):* The switching output is activated electronically when the assigned switching function is *not* logically triggered. When the function is logically activated, then the switching output is in the electronically inactive state (relay is passive, transistor output blocks current).

8.9.3 Safety criteria

CAUTION: Risk for connected devices/systems

- ▶ Before using the switching outputs, clarify the safety-relevant consequences for the case of the following operational troubles:
  - Power failure to the S700 (for example, local power failure, or accidental switching-off, or defective fuses)
  - Fault or defect in the S700 (for example, defect of a switching output)
  - Interruption of the electrical connection
- ▶ Observe the switching method:
  - Switching outputs which operate by the *open-circuit* principle will show the assigned function as being *non active*, when a power failure occurs.
  - Switching outputs which operate by the *closed-circuit* principle will immediately signal the assigned function as being *active*, when a power failure occurs.
- ▶ Carefully review the consequences. Make sure that no dangerous situation can be created when a failure or a defect occurs.

8.9.4 Available switching functions

Control signals

Function name	x	Function (when activated)
Zero gas path x	1 ... 2	The matching gas should be fed.
Test gas path x	1 ... 4	When the calibration cuvette is active (UNOR/MULTOR option, see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 24), “zero gas path 1” is activated.
Sample gas path		
External pump		Switch on the external sample gas pump.
switch on pt. x	1 ... 8	Activate sampling point x (see “Sampling point selector (option)”, page 119).

Status signals

Function name	x	Meaning (when activated)
failure [1]		Internal fault or defect. Simultaneously, the “Function” light shines red and a “FAULT” or “FAILURE” message is displayed (see “Status messages (in alphabetical order)”, page 186).*Attention:* This switching output is activated when *no* malfunction is present (closed-circuit principle).
service [2]		A calibration is running, or the “maintenance signal” has been activated manually (see “Activating the maintenance signal”, page 84), or a function in menu level 6 or 7 has been called up.[3] – This function corresponds to the NAMUR signal “function monitoring”.
fault [4]		Certain internal limit values are slightly exceeded. The “Service” LED and a “SERVICE” message are activated. This function corresponds to the status signal “service required” as defined by the German NAMUR requirements. – The cause for this signal does not yet reduce the S700 measuring ability, however a technician should correct the problem soon.
alarm limit x	1 ... 4	Meas. value is smaller/greater than the alarm limit (see “Setting alarm limit values”, page 91).
calibration active		Calibration is running.
auto. calibration		Automatic calibration is running.
output x	1 ... 4	Measured value output x works in output range 1. Not available for special version “THERMOR 3K” (see “Special version “THERMOR 3K””, page 194).
meas value pt. x	1 ... 8	Current meas. values are related to sampling point x (see “Sampling point selector (option)”, page 119).[5]
FAILURE sensor x	1 ... 3	Analyzer module x is not operational (explanation see “FAILURE sensor x”, page 186).[6]
SERVICE sensor x	1 ... 3	Current measured values from analyzer module x might be wrong (explanation see “SERVICE: Sensor x”, page 189).[6]
CALIBR. sensor x	1 ... 3	Calibration is running with analyzer module x.
FAILURE extern x	1 ... 2	The input signal at analog input INx (see “Analog inputs”, page 58) is too great (exceeds the maximum limit), or the internal processing of this signal is faulty because internal computation limits are exceeded. S700 The corresponding displayed measured value is unusable (probably wrong).
SERVICE extern x	1 ... 2	The input signal of analog input INx (see “Analog inputs”, page 58) is close to the maximum limit, or the internal processing of this signal in the S700 is close to internal computation limits.The corresponding displayed measured value is still correct.
CALIBR. extern x	1 ... 2	A calibration is running with the measuring component which represents the measuring signal from analog input INx (see “Analog inputs”, page 58). [6]
Flow sensor		The gas flow in the internal sample gas path is smaller than 50 % of the programmed limit value (see “Setting the flow monitor set point”, page 114).
Condensate sensor		Condensate is present in the internal sample gas path of the S700 (corresponds to status message “FAULT Condensate”, see “FAULT: condensate”, page 187)
meas.value output x	1 ... 3	Only for special version “THERMOR 3K”: measured value output x is active (detailed information, see “Special features of the “THERMOR 3K” version”, page 195).

[1]This function is permanently assigned to switching output REL1. If required, this function can also be assigned to other switching outputs.

[2]Is permanently assigned to switching output REL2. If required, this function can also be assigned to other switching outputs.

[3]Some of these menus will interrupt the S700 measuring function. That is why the status signal “service” is automatically activated when this menu level is accessed.

[4]Is permanently assigned to the switching output REL3. If required, this function can also be assigned to other switching outputs.

[5]After activating the next sampling point, a “dead time” will run down before the new status is indicated (see “Configuring the sampling point selector”, page 120).

[6]Display of built-in analyzer modules, see “Display of device data”, page 79.

8.9.5 Assigning the switch functions

1 Call-up menu 691 (`main menu → settings → [9] →` [code] `→ signal assignment`).
2 Select a category:

`Relay outputs`	= switching outputs REL4 ... REL8
`Transistor outputs`	= switching outputs TR1 ... TR8

3 Select the desired switching output.
4 Enter the code of the desired switch function. You can find the codes in the help information menu (press the [Help] key).
5 To reverse the switching function logic: Press [–] [Enter]. (In the display, reverse logic is symbolized with “ ! ”.)

Use the see “User Table: Switching outputs”, page 209 for planning and documentation.

8.10 Configuration of the control inputs

8.10.1 Functional principle

Each of the control inputs CI1 ... see “Available control functions”CI8 (see “Control inputs”, page 62) can be assigned to any of the pre-defined software control functions.

8.10.2 Available control functions

Internal controls

Function name	x	Function (when input is activated)
service block		The main menu is reduced to the functions “measuring display” and “device status”. Settings and calibrations cannot be made. A running calibration is terminated. – Corresponds to the NAMUR control input function “communication”.
pump on/off		Deactivates the fitted gas pump (if existing and activated via menu function; see “Switching the gas pump on/off”, page 81).
output x	1 ... 4	Output range 1 is selected for measured value output x (deactivated status means output range 2).*Attention:* Only effective as long as “External switching” is selected as measured value output (see “Selecting the output ranges”, page 95).
	1 ... 3	Only for THERMOR 3K: Measured value output/measuring component is activated (detailed information see “Special features of the “THERMOR 3K” version”, page 195)
hold sample pt. x	1 ... 8	Sampling point x is activated (see “Sampling point selector (option)”, page 119). When several control inputs of this type are activated at the same time, then the first sampling point will be activated.[1] “switch off pt. x” will have no influence.
switch off pt. x	1 ... 8	Sampling point x will be skipped when automatic switching is active (see “Sampling point selector (option)”, page 119). Can be activated for several sampling points.[1]
no drifts		Drift compensation is deactivated (means that the measured values will be calculated on the basis of the last basic calibration). Applies to all displayed measured values and measured value outputs.
sample value hold		“Freezes” all measured value outputs, to hold the value that is present when this function is activated (“sample hold” function).
auto.cal. x start	1 ... 4	Automatic calibration x (see “Automatic calibration”, page 133) is started. This function is triggered when switching from deactivated to activated state; maintaining the activated state does not trigger any further calibrations. – These control functions can be deactivated (see “Ignoring an external calibration signal”, page 138).
cal. stop		Interrupts a running automatic calibration.

[1]This has priority over the internal automatic sampling point selection (see “Configuring the sampling point selector”, page 120).

External status signals

Function name	x	Function (when input is activated)
zero gas x fault	1 ... 2	If at least one of these inputs is activated, then automatic calibrations will not be started, running calibrations will immediately be terminated, the “Service” LED is illuminated, and the switching output “fault” is activated. – For example, you could connect these inputs to devices which monitor the pressure of calibration gas cylinders.
test gas x fault	1 ... 4	
failure x	1 ... 2	These inputs can be used to connect external status signals. When the input is activated, the related status message is shown on the display (see “Status messages (in alphabetical order)”, page 186) and, if necessary, output via interface (see “Output of digital measured data”, page 102) and the related status output is activated (if set up; see “Available switching functions”, page 98).
fault x		
service x		

- You can reverse the logic of each control function (see “Assigning control functions”, page 100).
- Use the see “User Table: Control inputs”, page 210 for planning and documentation.

8.10.3 Assigning control functions

1 Call-up menu 6911 (`main menu` → `settings` → `[9]` → [code] → `signal assignment` → `signal inputs`).
2 Select the desired control input.
3 Enter the code of the desired control function. You can find the codes in the help information menu (press the [Help] key).
4 To reverse the switching function logic: Press [–] [Enter]. (In the display, reverse logic is symbolized with “ ! ”.)

- You may want to use the Table in see “User Table: Control inputs”, page 210 to plan and record your assignments.
- An overview of the programmed control inputs is displayed when you call-up the their current status (see “Status of the control inputs”, page 118).

8.11 Digital data transmission

8.11.1 Digital interface parameters

Function

These functions are used to set-up the parameters of the digital interfaces (connection, see "Digital interfaces", page 65). Data communication will only work if the interface parameters of all connected instruments are identical.

Setting

1 Call-up menu 64 (`main menu` → `settings` → `interfaces`).
2 Select `serial inter. #1` or `serial inter. #2`.
3 Check/make the following settings:

`Baud rate`	Data transmission speed of the interface. Select the highest value that the connected instruments will allow. Standard setting: `9600`
`Parity`	The parity bit (if used) monitors the character transfer. Standard for communication with PCs: `no parity`
`Data bits`	S700 only uses characters from the 7-bit range (ASCII code range 0 ... 127), but can also communicate in the 8-bit format. Standard for communication with PCs: `8 bit format`
`CR signal`	This function determines which characters the S700 sends at the end of a data line `CR` = Carriage Return; `LF` = Line Feed). Standard for output on PC printers: `CR LF`
RTS/CTS protocol	The RTS/CTS protocol is a hardware handshake procedure between sending (S700) and receiving unit, via the interface connections RTS (Ready To Send) and CTS (Clear To Send). ► Observe the notes on RTS/CTS protocol when operating with BUS converters (see "Creating an interface connection", page 203).
XON/XOFF protocol	The XON/XOFF protocol is a software handshake procedure where the S700 reacts to the XOFF and XON codes (received via the RXD connection). After switching the analyzer on or after a power failure, the `XON/XOFF protocol` is activated.

- You can test the data output (see "Testing electronic outputs (hardware test)", page 121).
- If the data transmission does not work even when all the interface parameters are identical, try a lower baud rate (on all connected devices).
- If the interface still does not work even at the lowest baud rate, check the electrical connections.

8.11.2 Output of digital measured data

Function

You can select which data the S700 will automatically transmit via interface #2 (hardware information, see "Digital interfaces", page 65).

Settings

1 Call-up menu 644 (`main menu → settings → interfaces → auto. reports #2`).
2 Activate or deactivate the desired data output:

`measured values`	• Set the time interval in which the S700automatically outputs measured values (1 ... 600 seconds). • To switch off the measured value output, select 0 seconds.
`status messages`	ON = the S700 sends every status change with a describing text message (see page 103).
`calib. results`	ON = after every calibration, the S700 sends the measured values of the test gases and the calculated calibration values.
`half hour average`	ON = on every full and half hour (controlled by the internal clock), the S700 will send the average of the measured values for all measuring components, taken over the last 30 minutes.

Data output format

Measured values (example)
`#MS 18.01.00 13: 46: 06  #6: 18.98 vol.% O2   883.6 ppm CO2   162.96 mg/m3 NO`

`#MS`	= header for the measured value output
`18.01.00 13:46:06`	= actual date/time
`#6`	= number of current sampling point (option; see "Sampling point selector (option)", page 119)
`18.98 vol.% O2` etc.	= measured value for measuring component 1, 2, 3, ...

Status messages (example)
`#AL 18.01.00 13:43:11  01 ON  calibration/maintenance`

`#AL`	= header for the status messages
`18.01.00 13:43:11`	= actual date/time
`01`	= message number
`ON`	= status has been activated (OFF = deactivated)
`calibration/maintenance`	= status message in text format (see page 103)

Calibration results (example 1)
`#Kx 18.01.00 13:43:10  SO2    200.00  201.37` `#Ky …`

`#KN1 … #KN2`	= calibration data for the zero gases
`#KP3 … #KP6`	= calibration data for the test gases
`18.01.00 13:43:10`	= actual date/time
`SO2`	= respective measuring component
`200.00  201.37`	= nominal value, measured value

Calibration results (example 2)
`#NE 18.01.00 13:46:00  SO2      -0.81%   -0.17%`

`#NE`	= header for zero point and sensitivity drift
`18.01.00 13:46:00`	= actual date/time
`-0.81%   -2.17%`	= zero point drift, sensitivity drift (see "Display of drift values", page 80)

Half hour averages (example)
`#HM 18.01.00 14:30:00   19.51   125.44   203.52`

`#HM`	= header for half hour averages
`18.01.00 14:30:00`	= actual date/time
`19.51   125.44   203.52`	= half hour value for measuring component 1/2/3

Possible status messages via interface #2

message text
calibration/maintenance
heating 1 ....
heating 2 ....
heating 3 ....
FAULT: temperature 1
FAULT: temperature 2
FAULT: temperature 3
start control 4
FAULT: controller 4
FAULT: signal #1
FAULT: signal #2
FAULT: signal #3
FAULT: signal #4
FAULT: signal #5
FAULT: electronic
FAULT: overrange #1
FAULT: overrange #2
FAULT: overrange #3
FAULT: overrange #4
FAULT: overrange #5
calibration active
auto. calibration active
Sample gas
zero gas 1
zero gas 2
test gas 3
Test gas 4
test gas 5
test gas 6
Measured value output 1: output range 1
Measured value output 2: output range 1
Measured value output 3: output range 1
Measured value output 4: output range 1
external pump
SERVICE: zero drift #1
SERVICE: zero drift #2
SERVICE: zero drift #3
SERVICE: zero drift #4
SERVICE: zero drift #5
SERVICE: sensitivity drift #1
SERVICE: sensitivity drift #2
SERVICE: sensitivity drift #3
SERVICE: sensitivity drift #4
SERVICE: sensitivity drift #5
FAULT: zero drift #1
FAULT: zero drift #2
FAULT: zero drift #3
FAULT: zero drift #4
FAULT: zero drift #5
FAULT: sensitivity drift #1
FAULT: sensitivity drift #2
FAULT: sensitivity drift #3
FAULT: sensitivity drift #4
FAULT: sensitivity drift #5
FAULT: pressure signal

message text
FAULT: condensate
FAULT: flow signal
SERVICE: flow
FAULT: flow
FAULT: zero gas 1
FAULT: zero gas 2
FAULT: test gas 3
FAULT: test gas 4
FAULT: test gas 5
FAULT: test gas 6
FAULT: IR source
FAULT: chopper
FAULT: filter wheel
FAULT: cal. cuvette
FAULT: internal voltages
FAILURE external message 1
FAILURE external message 2
Interruption ext. message 1
Interruption ext. message 2
Service external message 1
Service external message 2
Common alarm failure
Common alarm interruption
SOV sample pt. 1
SOV sample pt. 2
SOV sample pt. 3
SOV sample pt. 4
SOV sample pt. 5
SOV sample pt. 6
SOV sample pt. 7
SOV sample pt. 8
pt. 1 value available
pt. 2 value available
pt. 3 value available
pt. 4 value available
pt. 5 value available
pt. 6 value available
pt. 7 value available
pt. 8 value available
FAILURE: sensor 1
FAILURE: sensor 2
FAILURE: sensor 3
FAILURE: sensor extern 1
FAILURE: sensor extern 2
SERVICE: sensor 1
SERVICE: sensor 2
SERVICE: sensor 3
FAILURE: sensor extern 1
FAILURE: sensor extern 2
CALIBRATION: sensor 1
CALIBRATION: sensor 2
CALIBRATION: sensor 3
CALIBRATION: sensor extern 1
CALIBRATION: sensor extern 2

8.11.3 Printing internal configuration

Function

You can output the S700 configuration as a plain ASCII text Table, using serial interface #1 or #2 – for example, in order to print it.

The data is divided into the `config.` and `config. 2` sections (see Fig. 20). The data are output in the selected menu language (exception: Output in English when Polish selected) .

Making data backups, see “Data backup”, page 109

Call-up

1 Call-up menu 71(`main menu→ service → check values`).
2 Call-up `print config.` (menu 714) or `print config. 2` (menu 715).
3 To start the output, select `serial inter. #1` or `serial inter. #2`.

Fig. 20: Data output “print config.” and “print config. 2” (examples)

```
S 700 configuration from 17.12.02 13:16:21
==========================================

Program version     :  V. 1.26 from 17.12.2002
serial number      :               710790   (79211)
Release date        :            01.01.00
Device name          :               S 710
Housing type       :                  710
Hardware version    :                   2
Language            :             English

  options, hardware
Calibration cuvette  :                 OFF   (41117)
Internal pump      :                   OFF   (79223)
Pressure sensor      :                  ON   (79221)
Condensate sensor  :                    ON   (79224)
Flow sensor :                           ON   (79222)

  options, software
Remote control, AK :                    OFF   (79235)
Sampling point selector  :               ON   (79236)
Measuring components    :   SO2          CO         CO2         O2   Temp. C
2nd output range :         OFF         OFF         OFF        OFF       OFF
Range ratio > 10:1  :      OFF         OFF          OFF        OFF      OFF
Compensation      :         ON          ON         ON         ON        ON

Flow sensor         :                   20   (79222)
Gas pump on/off  :                     OFF    (31)
Pump capacity       :                   50    (651)
Step motor 0-Pt:                        93    (792481)
Step motor offset:                     144    (792482)
Lamp current    :                      590    (79246)
2 source symmetry :                    590    (79247)

Measuring components    :   SO2          CO         CO2         O2   Temp. C
Measurement compensation :    3           3           3          3         3
a               : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
b               : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
c               : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
d               : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
e               : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
f               : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
SO2                :         OFF        No         OFF        OFF       OFF
CO                 :         No         OFF        No         OFF       OFF
CO2                :         OFF        OFF        OFF        No        OFF
O2                 :         OFF        OFF        OFF        OFF       OFF
Temp. C            :         OFF        OFF        No         OFF       OFF

Temp. corr.   :              ON         ON         ON         ON        ON
Phys. unit   :              ppm       vol.%      vol.%      vol.%
Phys. start value :         0.0      0.0000      0.000      0.000      0.00
Phys. end value     :    5000.0      5.0000     25.000     25.000    600.00
Span gas     :              0.0      0.0000      0.000      0.000      0.00
Phase             :        70.0        70.0      246.0       70.0      70.0
pressure coeff.   :       1.079       0.684      1.477      1.090     0.000

Sensor plug    :        X 18       X 18       X 18       X 19   External 1
Sensor type        :     Multor     Multor     Multor  Oxor (DC)        ---
```

```
output range 1
Start value        :        0.0      0.0000       0.000       0.000
End value            :   5000.0      5.0000      25.000      25.000
Switch. pt. up :            0.0      0.0000       0.000       0.000

output range 2
Start value        :        0.0      0.0000       0.000       0.000
End value            :      0.0      0.0000       0.000       0.000
Switch. pt. down  :         0.0      0.0000       0.000       0.000

Alarm settings  :           1           2           3           4
Measurement components :    .           .           .           .
Alarm settings  :           .           .           .           .
Acknowledge     :           0           0           0           0

Signal assignment   : Signal inputs   Relay outputs Transistor outputs
1                  :                                  Failure!
2                  :                                  Maintenance
3                  :                                  Malfunction
4
5
6
7
8
 (! = logic: INVERS)
```

```
S 700 configuration 2 from 17.12.02 13:19:02
============================================

Program version     :  V. 1.26 from 17.12.2002
serial number     :           710790   (79211)
Device name         :            S 710

  options, software
Calib. results      :                ON   (6443)
AK-ID active       :                OFF   (6422)
sample-hold amp.  :                   0
Semi-continuous mode :                0
Back-flush filter   :                 0
Dilution step       :                 0
AK-ID               :                35   (6421)
Pressure gradient   :                 0
Flow adjustment low :                 0
Flow adjustment high:                 0
Counter:            :                 0

Measured values          :            0   (6441)
Status messages  :                    1   (6442)
El. connection:                       1   (6423)
Autom. answer :                       0   (642411)
Dialing mode                          1   (642412)

Ampl.quotients sig:                   0
Step motor type  :                    5
modulator freq.   :                   7   (79244)
Modulator type     :                  1   (79245)
Press. sensor damping:              120   (79554)
Quotients value    :                  0
Measuring components    :  SO2        CO         CO2          O2   Temp. C
ADC channel        :         0          0          0           3        13
Component index :           41         30         29          40        67
Delay time         :        21         21         21           0         0

Decimal places   :           1          2          2           2         0
Bargraph disp. range:        1          1          1           1         1
no over range al. :          0          0          0           0         0
No overflow alarm.:          0          0          0           0         0
Neg. meas. val. mask:     0.00       0.00       0.00        0.00      0.00
Pos. meas. val. mask:     0.00       0.00       0.00        0.00      0.00

Concen. factor    :    5000.00       5.00      25.00       25.00    600.00
Concen. scaling:       5000.00       5.00      25.00       25.00    600.00
ADC scaling [0]:       44.6311     0.2093     1.0000      1.0000    1.0000
ADC scaling [1]:        0.3052    82.7840     1.0000      1.0000    1.0000
ADC scaling [2]:        1.0000    -0.1781    49.2124      1.0000    0.0843
Calc. ZP drift  :       1.0000     1.0000    -1.1178    482.8556    1.0000
Calc. SP drift [0]:     1.0000     1.0000     1.0000      1.0000  309.9795

Calculate ZP drift  :   -0.6480     0.0821    -0.0749     -2.7270
0.0000
Calc. SP drift [0]:     1.0085     1.0000     1.0000      1.0000    1.0000
Calc. SP drift [1]:     1.0000     0.9828     1.0000      1.0000    1.0000
Calc. SP drift [2]:     1.0000     1.0000     0.9781      1.0000    1.0000
Last ZP drift   :       1.0000     1.0000     1.0000      1.0101    1.0000
```

```
  ADC results
Date zero gas meas. 1:   03.08.02          Date zeros gas meas. 1:
02.08.02
Time zero gas meas. 1:      05:08          Time zero gas meas. 2:
20:08
  ADC results
N1                 :    -820.55     402.35     337.06     -30.45      0.76
N2                 :    -817.87     427.38     292.21      24.02      1.56
sen. zg low temp. :       14731      14731      14731      14731     14731
sen. zg high temp :           0          0          0          0         0
Temp. corr.  :       -4.31e-03  -4.02e-02  +7.21e-02  -8.76e-02  -1.29e-03

  sensitivity
Date test gas meas. 1:   03.08.02          Date test gas meas. 2:
02.08.02
Time test gas meas. 1:      05:08          Time test gas meas. 2:
20:08
  ADC results
E1                 :   10823.59    8184.06   19243.82   17818.64      0.00
E2                 :   10477.75    8196.97   19444.44   17761.46      0.00
sen. sg low temp. :       14739      14727      14747      14747         0
sen. sg high temp. :          0          0          0          0         0
Temp. corr.  :       -5.26e-05  -2.44e-06  +1.95e-05  -9.82e-06  +0.00e+00

Number of  SPT        :                   5   (6251)
Man/auto SPT sel.:                        0   (6255)
Sampling points        :     1          2          3          4          5
Measuring duration per SPT :  30        30         30         30         30
Lag time per SPT   :          5          5          5          5          5
Activate SPT    :             0          0          0          0          0
```

8.12 Digital remote control settings

The S700 uses the interface #1 (explanation and connection, see “Digital interfaces”, page 65; settings, see “Digital interface parameters”, page 101) for digital communication.

Options for digital remote control:
- “Remote control with “AK protocol””, page 159.
- “Remote control with Modbus”, page 165.

8.12.1 Setting the ID character

Function

An individual identification character can be assigned to each S700 for digital remote control. The S700 will only obey commands which include its own ID character (unless this feature is disabled; see “Activating the ID character / Activating Modbus”, page 106).

Setting

1 Call-up menu 6421 (`main menu → settings → interfaces → communication #1 → AK-ID`).
The identification number set is displayed in two ways: The character on the left and the decimal ASCII code of the character on the right (e.g. `M 77`).
2 Enter the decimal ASCII code of the desired ID character (0 ... 127).
3 Press [Enter].

<table>
<tr><td>! = 33</td><td>- = 45</td><td>9 = 57</td><td>E = 69</td><td>Q = 81</td><td>] = 93</td><td>i =105</td><td>u =117</td></tr>
<tr><td>" = 34</td><td>. = 46</td><td>: = 58</td><td>F = 70</td><td>R = 82</td><td>^ = 94</td><td>j =106</td><td>v =118</td></tr>
<tr><td># = 35</td><td>/ = 47</td><td>; = 59</td><td>G = 71</td><td>S = 83</td><td>_ = 95</td><td>k =107</td><td>w =119</td></tr>
<tr><td>$ = 36</td><td>0 = 48</td><td>< = 60</td><td>H = 72</td><td>T = 84</td><td>’ = 96</td><td>l =108</td><td>x =120</td></tr>
<tr><td>% = 37</td><td>1 = 49</td><td>= = 61</td><td>I = 73</td><td>U = 85</td><td>a = 97</td><td>m =109</td><td>y =121</td></tr>
<tr><td>& = 38</td><td>2 = 50</td><td>> = 62</td><td>J = 74</td><td>V = 86</td><td>b = 98</td><td>n =110</td><td>z =122</td></tr>
<tr><td>’ = 39</td><td>3 = 51</td><td>? = 63</td><td>K = 75</td><td>W = 87</td><td>c = 99</td><td>o =111</td><td>{ =123</td></tr>
<tr><td>(= 40</td><td>4 = 52</td><td>@ = 64</td><td>L = 76</td><td>X = 88</td><td>d =100</td><td>p =112</td><td>| =124</td></tr>
<tr><td>) = 41</td><td>5 = 53</td><td>A = 65</td><td>M = 77</td><td>Y = 89</td><td>e =101</td><td>q =113</td><td>} =125</td></tr>
<tr><td>* = 42</td><td>6 = 54</td><td>B = 66</td><td>N = 78</td><td>Z = 90</td><td>f =102</td><td>r =114</td><td>~ =126</td></tr>
<tr><td>+ = 43</td><td>7 = 55</td><td>C = 67</td><td>O = 79</td><td>[= 91</td><td>g =103</td><td>s =115</td><td></td></tr>
<tr><td>, = 44</td><td>8 = 56</td><td>D = 68</td><td>P = 80</td><td>\ = 92</td><td>h =104</td><td>t =116</td><td></td></tr>
</table>

8.12.2 Activating the ID character / Activating Modbus

Function

You can determine if the S700 only reacts on remote control commands which contain its own ID character (see "Setting the ID character", page 105), or if the S700 reacts on all remote control commands, independent of the ID character. – This menu function is also used to activate the Modbus remote control functions (see "Remote control with Modbus", page 165).

Setting

1 Call-up menu 6422 (`main menu → settings → interfaces → communication #1 → AK-ID-active`).
2 Select the desired mode:

`without AK-ID`	ID character will be ignored – the S700 will obey all of the remote control commands it receives. [1]
`with AK-ID`	ID character will be observed – the S700 will only obey remote control commands with matching ID character. [1]
`with AK-ID MODBUS`	Like `with AK-ID`, but in addition the remote control with Modbus commands is enabled.

[1] Modbus functions (option) disabled, i.e. Modbus commands will be ignored.

8.12.3 Setting the installed connection

Function

This function applies for the data communication with the Modbus protocol (see "Remote control with Modbus", page 165).

There are several options for the electrical connection (see "Creating an interface connection", page 203); specify the connection used here.

+i On the S700, interface #1 is used for the connection.

Setting

1 Call-up menu 6423 (`main menu → settings → interfaces → communication #1 → elect. connection`).
2 Set the installed connection:

`serial, single`	One S700 is connected directly to the PC via the interface
`serial, bus`	Several S700s are connected via BUS converters to the PC
`modem, single`	One S700 is connected via modem to the PC
`modem, bus`	Several S700s are connected via modems and BUS converters

8.12.4 Configuring the modem connection

Function

These functions are required if you have a digital electrical connection via modem (and you intend to use it).

Settings

1 Call-up menu 64241(`main menu` → `settings` → `interfaces` → `communication #1` → `modem` → `modem settings`).
2 Check/adjust the following settings:

`auto. answer`	• `auto. answer off` = the modem will not respond to incoming calls. You will need to connect the telephone line via menu command (`receive call` see "Modem control", page 108). To do this, you must be able to notice when a call is coming (for example, by listening to the modem loudspeaker). • `after x rings` = the modem will wait for the number of rings to pass and then will automatically connect to the incoming call.
`dialing mode`	Adjust the dialing mode to the telephone system where the modem is installed: • `tone dial` = multiple frequency dialing mode (MFV) • `impulse` = impulse dialing mode (IWF) You can also change the dialing mode when dialing a number (see "Modem control", page 108).
`store setting`	Send a command to the modem: "Store the current settings permanently." As a result, the modem will keep the current settings even after being shut off or after a power failure.

+i The modem connected to the S700 must accept standard AT commands (Hayes-compatible commands). Otherwise the S700 remote control commands will not work.

8.12.5 Modem control

Function

If you have a modem connected to interface #1, then you can remotely control its basic functions from the S700.

Actions

1 Call-up menu 6424 (`main menu → settings → interfaces → communication #1 → modem`).
2 Possible actions:

`initialisation`	Restarts the modem and sends the settings for answering and dialing mode from the gas analyzer to the modem. An existing telephone connection will be disconnected, and the modem will delete all existing internal error messages. *Attention:* A remote control command just being received can then be truncated. This can produce errors in the S700.
`dialing`	Calls up a menu where you can enter a telephone number that the modem should call. – You can integrate the following special characters into the telephone number: ● **.** (decimal point) = dial pause of 3 seconds (for example, to wait for an “external line” when dialing from an internal telephone system). On the display you will see a “ , ” (= related Hayes command). You can enter multiple dial pauses in succession, if required. ● – (minus sign) = switch to the alternative dialing mode (see “Configuring the modem connection”, page 107). The S700 will display “T” (tone dialing will follow) or “P” (impulse dialing will follow) – depending on which dialing mode was previously selected. You can switch the dial mode only once in a telephone number.
`receive call`	The modem connects to the incoming call. To use this function, you must have selected “manual answer” (see “Configuring the modem connection”, page 107), and you need to notice when a call is coming in (for example, via the modem’s loudspeaker).
`abort`	The modem will immediately disconnect an existing telephone connection. *Attention:* A remote control command just being received can then be truncated. This can produce errors in the S700.

+i If a telephone connection was established from the S700, then you need to use the `abort` function in the S700 to terminate the connection.

8.13 Data backup

8.13.1 Using an internal backup

Functions

- The data backup menu functions allow you to save a copy of S700's current working state. The data backup includes
  - all individual settings
  - all the individual S700 parameters
  - the calibration at the time of the backup

  The S700 can store *two* such copies: "Last backup" and "2nd last backup". Both copies can be re-activated. As a result, it is possible to store two working conditions and restore them if required.
- In addition, S700 automatically makes a backup copy of the operating state after each successful calibration.
- You could also restore the original delivered state (factory settings). This can be useful when the S700 is not functioning correctly and you suspect this is due to confusing and unsuitable settings: First save the current operational state and then reactivate the factory settings to temporarily create "reliable conditions" for tests.

> - Saving the settings on an external computer, see "Using an external backup", page 110
> - Plain text output of the configuration data, see "Printing internal configuration", page 104

Procedure

1 Call-up menu 694 (`main menu` → `settings` → `[9]` → [code] → `data storage`).
2 Select the desired function:

`store data`	saves the current working state as the "last back-up" (previous "last back-up" settings will become "2nd last back-up")
`last back-up`	restores the working state of the "last back-up"
`2nd last back-up`	restores the working state of the "2nd last back-up"
`after calibration`	restores the working state which was automatically saved after the latest successful calibration procedure
`factory settings`	restores the original factory-delivered state

> When restoring a "backup", the newest changes of the working state are lost - unless you have previously saved the settings with `save data` or `send data` (see "Using an external backup", page 110).

3 Press [Enter] to start the procedure.

8.13.2 Using an external backup

Functions

Menu `data transmission` is used to transfer the configuration of the S700 (all measuring parameters and settings) to a PC (download) and to upload it again to the S700 (upload). The data is stored in a hex-coded file with a size of some kilobytes. Application options:

- You can generate a back-up copy of all data and reload the data into the S700 if required – for example, after a major breakdown.
- When the S700 electronic board or the memory module needs to be replaced, you can reload the individual data into the new electronics.

▸ Do *not* use the `data transmission` function to copy data from one gas analyzer to another one.

These data include parameters which depend on the individual characteristics of the built-in analyzer modules. Even if analyzers are equipped with exactly the same types of modules, their internal data sets will be different. The gas analyzer will not work correctly with “foreign” data.

- Output of configuration data in plain text form, see “Printing internal configuration”, page 104.
- Load firmware (internal software), see “Firmware update”, page 113.

Requirements

For the data transmission you need:

- a computer with a RS232 serial interface
- a connecting cable to interface #1 of the S700 (see “Connecting the interfaces”, page 65)
- a program which can operate the data transmission between the computer and the connected device (terminal program).

One of the programs you could use is “HyperTerminal” which is a standard part of the Windows operating system. You can start “HyperTerminal” without making a connection; this allows you to use HyperTerminal’s Help function, to become familiar with the program.

Preparations

NOTE:

Uploaded data will replace the analyzer’s current settings.

▸ Prior to the upload, save the analyzer’s current status, if required (external, see “Data backup procedure”, internal, see “Using an internal backup”, page 109).

---

1 Connect the computer with the serial interface #1 of the S700 (see “Digital interfaces”, page 65).

2 In the computer, start the terminal program. Configure it as follows:
   - ▸ Set-up the same interface parameters as for the S700 (see “Digital interface parameters”, page 101).
   - ▸ Set-up the data transmission mode in such a way that the data are transferred as a text file (ASCII data), not as binary data.

   In “HyperTerminal”, the correct transfer mode is “Text file” – not “Data file”.

Data backup procedure

Use this procedure to save S700's current data:

In the S700	In the terminal program
	1 Start-up the interface connection to the S700.
2 Call-up menu 695 (`main menu` → `settings` → [9] → `[code]` → `data transmission`).	
3 Select `send data`.	
	4 Start data recording for ASCII data.[1]
5 Press [Enter] (this will start the data transmission).	
6 Wait until S700 indicates that the data transmission is finished (takes 40 seconds at least).	
	7 Stop data recording.[2]

[1] In "HyperTerminal": [Transfer] → [Capture text...] → select desired storage location (folder) and enter the file name under which the S700 data are to be saved as backup copy → [Start].
[2] In "HyperTerminal": [Transfer] → [Capture text...] → [Stop].

! ▶ To finish with data recording, always use the corresponding menu command of the terminal program.
If the terminal program is just being closed instead, the recorded file may become unusable (file not correctly closed).

Data restore procedure

Use this procedure to restore S700's data from a backup file:

In the S700	In the terminal program
	1 Start-up the interface connection to the S700.
2 Call-up menu 695 (`main menu` → `settings` → [9] → `[code]` → `data transmission`).	
3 Select `receive data`.	
4 Press [Enter] (makes S700 ready to receive data).	
	5 Send the S700 data backup file as an ASCII text file.[1]
6 Wait until S700 indicates that the data transmission is finished (takes 40 seconds at least).[2]	

[1] In "HyperTerminal": [Transfer] → [Send Text File...] → select the desired file → [Open].
[2] Display messages, see page 112

Error messages of the data restore procedure

During `receive data` the S700 monitors the data transmission. In case of a malfunction, the S700 stops the data transmission and indicates the malfunction on the display:

<table>
<tr><th>Display message</th><th>Meaning</th><th>Remedy</th></tr>
<tr><td>--OK--</td><td>the data transmission was successful</td><td>–</td></tr>
<tr><td>READ-TIMER</td><td>no characters received</td><td>Check the electrical connection (plug connectors, cables).</td></tr>
<tr><td>READ-BREAK</td><td rowspan="3">error occurred during character transmission</td><td rowspan="3">Set transmission delay settings in the terminal program. Proceed as follows:
1 Set a line delay; set a short delay initially. Then try the data transmission again.
2 If this does not help, increase the line delay step-by-step, up to approx. 10 ms.
3 If this does not help: Deactivate the line delay. Instead, set a character delay. Start with the smallest available value.
4 If this does not help, increase the character delay step-by-step until the data transmission works.</td></tr>
<tr><td>READ-ERROR</td></tr>
<tr><td>READ-CHAR</td></tr>
</table>

- Transmission delays will increase the time required for the data transmission. Example: A character delay of 10 ms increases the time required for the data transmission to about 3 minutes.
- On some computers, the real delay is much greater then the set value.

8.14 Firmware update

Function

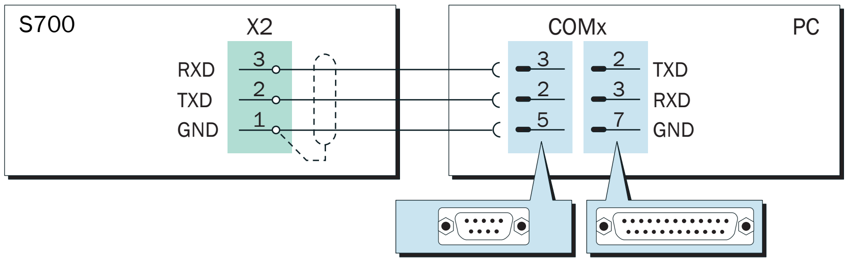
You can load the S700's internal software (firmware) from a PC into the S700 – for example, to install an new firmware version. You will need:

- a PC with an RS232 serial interface and the operating system Windows 3.X/95/98/2000/XP
- a connecting cable to the S700 interface #1
- the upload program FLASH.EXE
- a current version of the file 7XX.BIN (contains the S700 firmware)

Interface connection

Three interface connections are required:

Fig. 21: Minimum interface connection for the program loader function



- Please use a shielded cable.
- Cable length should not exceed approx. 2 meters (7 feet).
- You do not need to adjust the interface parameters – this will automatically be done by the upload program.

Procedure

1 Connect the PC to the S700 serial interface #1 (see Fig. 21).
2 On the PC: Store the FLASH.EXE and 7XX.BIN files in the same folder.

CAUTION: Risk for connected devices/systems
As long as the `program loader` function is activated, the S700 is not performing any measuring operation.
▶ Make sure that this situation cannot cause problems on connected devices.

---

3 *In S700:* Call up menu 76 (`main menu` → `service` → `program loader`) and start the function with [Enter].
   – The S700 then shows a message that it is waiting for data communication.
4 *On the PC:* Start FLASH.EXE.
   – The PC will show the messages of the upload program. The estimated remaining upload time is indicated.
   – The S700 software is divided into several “blocks”. The upload program will check which blocks need to be updated and will only upload the new blocks.
   – When the upload procedure has been completed, the S700 will re-boot.
5 Wait until the S700 `main menu` appears on the S700. Then the S700 is ready for use again.

8.15 Volume flow control

8.15.1 Setting the capacity of the gas pump

Function

Using this menu function, you can change the internal power supply to the built-in sample gas pump (option). This allows you to set the delivery capacity of the pump.

> If the S700 has a built-in gas pump, it is recommended to use this function to set the desired gas flow rate. It is more useful than operating the pump at full power and then reducing the flow with a regulating valve. When the load on the pump is reduced, it will have a longer life.

Setting

1. Call-up menu 651 (`main menu → settings → gas flow → pump capacity`).
2. Set the `status` value which gives the desired flow.

8.15.2 Setting the flow monitor set point

Function

The flow sensor (option) generates a fault signal when the sample gas flow in the sample gas path of the S700 is below the selected flow limit. This allows you to monitor the sample gas flow.

The fault indication works in two levels:

1. When the flow is only *slightly* below the flow limit, the S700 will output the status message SERVICE: gas flow (the LED “Service” and the status output “service required” will be activated simultaneously).
2. When the flow is *significantly* below the flow limit (less than 50 % of the set limit value), then `FAULT: gas flow` will be displayed (the “Function” LED is red and the status outputs “failure” and “service” will be activated).

Setting

1. Call-up menu 652 (`main menu → settings → gas flow → flow limit value`).
2. Set the desired limit value. The setting will approximately correspond to the flow in liters per hour (the exact relation depends on each individual flow sensor).

> If you need an accurate setting:
> 1. Connect an external flowmeter to the sample gas outlet.
> 2. Adjust the actual gas flow to the desired flow limit.
> 3. *In menu 652:* Determine the setting value by trial where the S700 outputs the `SERVICE: gas flow` message.

8.16 Displaying internal data

8.16.1 Measuring signals for the measuring components

Function

For service purposes, you can check the current measuring signals for all measuring components. These values come from the built-in analyzer modules or, if this feature is provided, from analog inputs (see “Analog inputs”, page 58).

“ADC values” are displayed: These are the digitalized values of the analog measuring signals and serve as input signals for digital measured value processing. ADC values include analog amplification of the measuring signals, but no digital computation or correction.

> +i The analog amplifications are variable: The optimum amplification for the measuring signals of the analyzer modules is determined during a basic calibration. For measuring signals fed-in via analog inputs, the amplification factor is manually programmed at the factory.

Typical values

- The ADC values will permanently fluctuate somewhat, even if the measured values are constant.
- When the measuring range end value is measured (which means, when the matching test gas flows through the analyzer module), “optimum” ADC values are in the range of `18000` ... `24000`. This is should be true directly after a basic calibration.

> +i
> - If ADC values below `10000` are displayed for the measuring range end value, then a basic calibration should be made, in order to re-optimise the measured value processing (see “Basic calibration”, page 145).
> - If the ADC value remains constant for an extended period of time, then the analyzer module is possibly defective, or the electrical connection is interrupted.

Call-up

Call-up menu 7111 (`main menu` → `service` → `check values` → `analog signals` → `meas. signals`).

8.16.2 Status of the internal controller

Function

This control function shows the actual state of the internal controllers:

- Controllers 1 to 3 are used for temperature control of the analyzer modules.
- Controller 4 does not have a function at this time (reserved for future applications).

Call-up

1 Call-up menu 7112 (main menu → service → check values → analog signals → controller).
2 Select the desired controller (1 ... 4).

value	actual measured value of the sensor
nominal value	set point (factory setting)
counter	time delay of the temperature monitor (in seconds). When the actual temperature is outside of the nominal range, the counter will advance by 1 each second. FAULT: Temperature is displayed when the counter exceeds the value 20. As soon as the temperature returns to nominal range, the counter begins counting backwards. After power-on, the counter starts with 128.
cycle	current on/off ratio for the controller, in % (minimum value = 0.0, maximum value = 99.9)
not available	= the controller electronics are physically not present, or the controller is not activated in the software.

8.16.3 Signals of the internal sensors and analog inputs

Function

This function displays the actual signals of the internal sensors and the analog inputs.

Call-up

▶ Call-up menu 7113 (main menu → service → check values → analog signals → extra sensors).

pressure hPA	measured value of the built-in pressure sensor (option)
flow %	measured value of the flow sensor (option, see “Setting the flow monitor set point”, page 114)
source V	supply voltage of the infrared source of the analyzer module UNOR or MULTOR (standard nominal range: 6.0 ... 7.5 V)
external 1 V	analog input signals (see “Analog inputs”, page 58)
external 2 V	

8.16.4 Internal supply voltages

Function

This control function shows the internal supply voltages: Nominal values are shown on the left and current actual values on the right.

If an actual value is outside the allowable range, `FAULT: int.voltage` is displayed. In such cases you may want to use this control function to locate the error source.

Call-up

▶ Call-up menu 7114 (`main menu → service → check values → analog signals → supply voltages.`).

Table 9: Internal supply voltages

Nominal value	allowable actual value
+24 V	18.0 ... 30.0 V
+24 V ext[1]	18.0 ... 30.0 V
+15 V	14.0 ... 16.0 V
–15 V	–14.0 ... –16.0 V
+12 V	9.5 ... 16.5 V
+5 V	4.5 ... 5.5 V
–5 V	–4.5 ... –5.5 V
0 V	–0.2 ... 0.2 V

[1] applies to auxiliary voltage outputs (see Fig. 15, page 61 and Fig. 16, page 61-)

Internal electronics fuses, see “Internal fuses”, page 185.

8.16.5 Internal analog signals

Function

The `overview` function displays the actual internal analog signals. These values can help a manufacturer’s service technician to diagnose the reason for a device malfunction. Which signals are shown depends on the individual S700 configuration.

Call-up

▶ Call-up menu 7115 (`main menu → service → check values → analog signals → overview`).

8.16.6 Bridge adjustment (THERMOR)

Function

If a THERMOR analyzer module is fitted, the S700 analyzes the individual characteristics of the module, and electronic control and signal processing are automatically adjusted to analyze the measuring component with the desired measuring range. The displayed status value (`0` ... `4095`) is a criterion for the “balance” of the electronic bridge in the THERMOR module.

Call-up

▶ Call-up menu 712 (`main menu → service → check values → bridge setting`).

8.16.7 Linearisation values

Function

The linearisation values represent the parameters which are used to compute a linear curve from the analyzer module's curve characteristic. Moreover, the linearisation values include the parameters for the mathematical compensation of cross-sensitivity effects.

Call-up

1. Call-up menu 713 (`main menu→ service → check values → linear. values`).
2. If the S700 measures several measuring components: Select the measuring components for which you want to see the linearisation values.
3. The following values will be displayed in tabular form:
   - Title: Date on which values were computed
   - Left column: Physical nominal value
   - Right column: Associated internal measured value

   When you press [Enter] or [<], related measured values for the other components will be displayed (used for internal cross-sensitivity compensation).

8.16.8 Status of the control inputs

Function

You can display the current electronic state of all control inputs (see "Control inputs", page 62).

Call-up

▶ Call-up menu 716 (`main menu → service → check values → control inputs`).

Setting	Function
0	the input is electronically passive (no current)
1	the input is electronically activated (current is flowing)
!	the input works with reverse logic

8.16.9 Program version

Function

This function shows you:

- Device name of the S700 (factory setting)
- Version number and release date of the built-in software (firmware)

Call-up

▶ Call-up menu 717 (`main menu → service → check values → program version`).

8.17 Sampling point selector (option)

The following information is only valid for analyzers equipped with the option “sampling point selector”.

8.17.1 Function of the sampling point selector

Sampling points are extraction points for the sample gas. With the option “sampling point selector”, the S700 can control up to eight sampling points (i.e. it can give commands to switch the sample gas path):

- Display delay time (after switching-over) and sampling time can be set individually for each sampling point.
- Automatic switching can be reduced to include only some of the connected sampling points.
- Control inputs for external sampling point selection can be set-up (see “Configuration of the control inputs”, page 99).

8.17.2 Notes on the sampling point selector

... for the measured value display	• Measured values shown on the display are always the current measured values of the analyzer modules, independent from the sampling point switching. • The current sampling point is indicated with a number in the top line of the measured value display (see “Measuring displays”, page 74)
... for the measured value outputs	• If the S700 only measures one measuring component and two, three or four sampling points are set, then each measured value output automatically represents one of the sampling points. Each measured value output displays current measured values as long as the associated sampling point is activated. When other sampling points are active, the measured value output constantly displays the measured value that was last measured with its associated sampling point (“sample hold” function). – The settings for measured value output 1 are automatically valid for all the other measured value outputs. • If the S700 measures more than one component or is set-up to sample more than four sampling points, all measured value outputs will permanently display the current measured value of the assigned measuring component. Switching outputs can be used to identify the current sampling point (see “Configuration of the switching outputs”, page 97). It is not possible to assign a measured value output to a certain sampling point.
... for the digital measured value out-puts	• Digital measured value outputs via (see “Output of digital measured data”, page 102) are given with a sampling point identification. • After switching to another sampling point, the digital measured value output are interrupted until a “dead time” has run down (see “Configur-ing the sampling point selector”, page 120).

8.17.3 Configuring the sampling point selector

Function

You can set how many sampling points the S700 should consider, and set-up individual times for each sampling point. To use this function practically, switching outputs have to be assigned to toggle the sample gas path to the sampling points (see “Configuration of the switching outputs”, page 97), and relevant external equipment (e.g. solenoid valves) installed.

Settings

1 Call-up menu 625 (`main menu` → `settings` → `measurement` → `sample p. select`).
2 Make the following settings:

`No. of sample pts.`	▶ Enter the number of connected sampling points (or the number of points you currently want to use). ● If a smaller number is set later, the remaining sampling points will be deactivated but their settings will still be held in memory. ● If the S700 measures only one measuring component and less than 5 sampling points are set-up, this will effect the assignment of the measured value outputs (see “Notes on the sampling point selector”, page 119).
`Sample time per pt.`	1 Select which sampling point this setting should be applied to. 2 Enter the activation period for this sampling point during automatic sampling point selection by the S700 (0 ... 3600 s). (This determines how long the related switching output is activated see “Configuration of the switching outputs”, page 97.)
`Dead time per pt.`	1 Select which sampling point this setting should be applied to. 2 Enter how long the S700 should wait after activating the sampling point before it begins to send measuring data via interface #2 (0 ... 300 s). When this time has passed, the analyzer module should be completely filled with the new sample gas, and the related measured value should be at the 100 % level (criteria for this setting, see “Setting test gas delay time”, page 138).
`Activate pt.`	`yes` = the sampling point will be activated during automatic sampling point switching. [1] `no` = the sampling point will not be activated during automatic switching (however, it can still be activated via menu command or via switching output).
`man/auto pt. select`	`0` = automatic sampling point selection is activated (following the `activate pt.` and `sample time per pt.` settings). `1` to `8` = the related sampling point is activated.

[1] Control inputs with the function “hold sample pt. x” and “switch off pt. x” have priority over the automatic sampling point selection (see “Configuration of the control inputs”, page 99).

8.18 Testing electronic outputs (hardware test)

Function

The functions in the `hardware test` menu serve to individually control and test each S700 electronic output. Furthermore, the digital interfaces can be tested as well. This allows you to test the electrical connections and interaction with external devices, or to test the S700 output hardware.

The hardware test function is applied to one selected output. All the other outputs will remain in operation.

CAUTION: Risks to connected devices

- When the test function is started in the menu
  - the selected output will be set to the selected electronic status
  - the operational function of this output is disabled.
- When the test is running and no key is being pressed for some minutes, the selected output will automatically be reset to operating state.

▶ Make sure that the test situation cannot cause problems at connected devices.
▶ During the test, consider the automatic reset. Make sure that the automatic reset cannot cause problems at connected devices.

Call-up

1 Call-up menu 72 (`main menu` → `service` → `hardware test`).
2 Select the desired test function:

`measured value outputs`	1 Select the desired measured value output (OUT1 ... OUT4). 2 Set the value that the output should permanently display (0 mA = 0 % / 20 mA = 100 %).
`relay group`	Each relay for the control and status outputs[1] can be activated individually: [2] 1 Select the desired switching output (REL1 ... REL8). 2 Press [Enter] to change the status of the relay.[3] – ON = relay is activated (working state) – OFF = relay is deactivated (resting state)
`transistor group`	Each transistor output[1] can be activated individually: [2] 1 Select the desired transistor output (TR1 ... TR8). 2 Press [Enter] to change the status of the output circuit.[3] – ON = output is activated (transistor is conducting) – OFF = output is deactivated (transistor is blocked).
`test interface #1`	As long as this function is selected, the S700 sends certain lines of characters (shown on the display). This allows you to check if data transmission to a connected device is working. [4]
`test interface #2`	

[1] See also "Switching outputs", page 59.
[2] The activation will be automatically switched off after 60 seconds – unless this is done manually before.
[3] Repeat as often as you like (toggle switch).
[4] If the connected printer does not print exactly the same characters as shown on the display, then the printer is probably not set on the standard ASCII character set ("US character set").

8.19 Reset

Function

A `reset` restarts the S700 microcomputer in the same way as switching the power off and on would do. The signal processing will restart. Stored values will remain unchanged.

Procedure

CAUTION: Risk for connected devices/systems
During a reset, all S700 functions are shutdown temporarily. This includes measured value outputs and status signals.
▶ Make sure that this situation cannot cause problems on connected devices.

1 Call-up menu 75 (`main menu → service → reset`).
2 Press [Enter] to activate a reset.

9 Calibration

9.1 Introduction to the calibration of the S700

Why is calibration necessary?

It is unavoidable that the characteristics of optical and electrical components will slightly change during the weeks of operation. These changes affect a high-precision measuring system and result in small changes of the measuring results. This effect is known as drift.

To compensate for the drift, a gas analyzer must regularly be calibrated. A calibration means that first the measuring result of the analyzer is checked, then the offset from the nominal value is adjusted to bring the analyzer back to the true reading.

The two important parameters in the measuring system are:

- The *zero point (*defined as the measuring result when the cause for a particular measuring effect is not present or should not be present).
- The *sensitivity (*defined as the relationship between the value of the measuring effect and the displayed measured value).

There is a zero point drift and a sensitivity drift for each measuring component. Each must be determined and corrected independently.

How does a calibration procedure in the S700 work?

During a calibration, the S700 automatically compensates for drifts in the following way:

1. A test gas is fed into the S700; the true concentrations of the measuring components in test gases are known. The nominal values are the true concentrations of the measuring components in the test gas.
2. The S700 measures the concentrations of the measuring components in the test gas (measured values).
3. The S700 calculates the drifts, i.e. the differences between the measured values and the nominal values.
4. The S700 checks if drift compensation can still be done by mathematical computation. If it is possible, the internal values for zero point and sensitivity drift compensation are automatically adjusted. If this is no longer possible, a malfunction message is displayed – which means that the measuring system should be inspected and re-adjusted by the manufacturer or a trained skilled person.

Theoretically, a complete calibration requires that this procedure is performed twice for each measuring component – once for the zero point and once for the sensitivity. Practically, in most applications, some parts of the procedure can be combined into one step – for example, a zero point calibration for all measuring components.

Running a calibration

You can manually control the calibration procedure using the menu functions so that you can run a calibration step-by-step. Alternatively you can program the S700 so that it will run through an automatic calibration – initiated by a start command or in regular time intervals. In addition, you can program up to four different calibration procedures to cover different requirements (see “Setting-up an automatic calibration”, page 135).

When is it necessary to perform a calibration?

The S700 should be calibrated

- after start-up;
- during operation at regular intervals (weekly to monthly).

The calibration cuvette – a substitute for test gases (UNOR, MULTOR)

The analyzer modules **UNOR** and **MULTOR** can be equipped with a “calibration cuvette”. This option allows to make routine sensitivity calibrations of the UNOR and MULTOR components without the need of test gases (see “Simplifying the calibration gas requirements”, page 128).

When the calibration cuvette is active, zero gas must flow through the S700; the relevant switching output is activated automatically. The nominal values of the calibration cuvette should periodically be checked (see “Calibration of the calibration cuvette (option)”, page 150).

General variations of the calibration procedure

A calibration can either run automatically or be manually controlled:

- *Automatic calibration*
  For an automatic calibration, the calibration procedure is completely controlled by the S700, including the calibration gas feed. This requires an external gas supply (for example, from gas cylinders) and automated switching devices (for example, solenoid valves), to deliver the calibration gas to the analyzer. Before an automatic calibration is started, the associated settings must have been made: the nominal values for the calibration gases (see page 136), the test gas delay time (see page 138), the calibration measuring interval (see page 139). When all this has been done, you only need to push one button in a menu or give the start signal via a control input to run an automatic calibration.
  In addition, periodical automatic starts can be programmed (see “Setting-up an automatic calibration”, page 135).
- *Manual calibration with automatic feed of test gases*
  This type of calibration requires the same external installation for calibration gas feed as an automatic calibration. However, you control the calibration procedure. This allows you to supervise each calibration step and repeat single steps if required.
- *Manual calibration with manual feed of test gases*
  In this version, you control each calibration step as in B above. However, the calibration gas feed is not controlled by the S700, instead you are responsible for feeding in these gases “manually”. External automatic devices for calibration gas feed are not required.

> Please note the special information which applies to the calibration of the “THERMOR 3K” version (see “Calibrating the special version THERMOR 3K”, page 157).

9.2 Guideline for calibrations

This section includes general recommendations for calibration gas feed and calibration procedures. Please note that special systems (for example, process applications with a complex gas conditioning system) may need an individual concept for calibrations.

1. *Routine calibration:* Perform normal calibrations as described in this chapter in the specified maintenance intervals (see “Maintenance plan”, page 174). Observe the following rules:
   - *Test gas mixtures allowed:* Test gas mixtures containing several measuring components may be used for normal calibrations.
   - *Calibrating the sample gas cooler:* If the sample gas conditioning is equipped with a sample gas cooler, feed the zero and test gas in front of the sample gas cooler (also applies for the zero gas for calibrations with calibration cuvette). Thus the physical influence of the cooler is identical during measurement and calibration and will be compensated.
   - *Leaving out the H2O calibration:* Do not calibrate the measuring component H_2O during routine calibrations (neither zero point nor sensitivity).
2. *Full calibration:* For analyzers with “internal cross-sensitivity compensation” (option), a full calibration should be performed in certain, long time intervals; a full calibration is also required after certain technical changes (see “Full calibration”, page 144).

9.3 Calibration gases

9.3.1 Programmable calibration gases

The S700 allows you to enter nominal values for 6 different calibration gases:

- 2 “zero gases” for zero point calibration of all measuring components (see “Zero gases (calibration gases for the zero point)”, page 126)
- 4 “test gases” for sensitivity calibration (see “Test gases for sensitivity calibration”, page 127).

The nominal values must be set prior to starting a calibration.

- This Manual provides a Table where you can record the nominal values of the calibration gases (see “User Table: Measuring components and calibration gases”, page 207).
- You can program 4 different automatic calibration routines where you can use the 6 calibration gases as you wish (see “Different automatic calibration routines”, page 134).

9.3.2 Zero gases (calibration gases for the zero point)

Standard zero gas

As a rule, zero gas should not produce a measuring effect for the measuring components which are zero-calibrated with this gas – which means that the nominal value is “0”. Usually nitrogen can be used as the zero gas; either “technical” or “top grade” quality should be used, depending on the application.

However, you can set particular nominal values for the zero gases. This may be useful in special applications if you want to use a zero gas which causes the analyzer to give a response signal. You need to know the quantitative effect and must take it into account when setting up the nominal values (usefulness for OXOR-P, see “Cross-sensitivity compensation with OXOR-P”, page 156).

Special zero gases

- *Air:* In some cases, air can be used as zero gas (see “Simplifying the calibration gas requirements”, page 128).
- *Carrier gas:* For some applications, the S700 is optimized for a certain standard sample gas composition (“carrier gas”). In this case, the zero gas should probably be a gas mixture which corresponds to the carrier gas.
- *H_2O cross-sensitivity:* Special information applies for measuring components with uncompensated H_2O cross-sensitivity (see “Calibrating “H2O cross-sensitive” measuring components”, page 156).
- *Analyzer module* UNOR *with option “flowing reference gas”:* For a S700 with this equipment, use a zero gas as span gas for calibrating the measuring components which are to be measured with the UNOR module (see “Display of measuring ranges”, page 77).
- *Analyzer module* THERMOR: For a zero point calibration of measuring components to be measured with a THERMOR module, use the gas or gas mixture which is stated on the enclosure (physical zero point) – e.g. dry air, N_2, H_2, He, CO, CH_4, Ar or another gas or gas mixture.
- THERMOR and OXOR-P: The zero gas may also contain the measuring component which is measured by the THERMOR-/OXOR-P module – and this up to a concentration which corresponds to 80 % of the physical measurement span. However, the nominal value for the zero and test gas must differ by at least 10 % (relative to the physical measuring span).
- OXOR-P: For applications where large cross-sensitivities are present, the “interfering gas” or a gas mixture which represents the average composition of sample gas can be used as zero gas. In this way, the calibrations would physically compensate for the cross-sensitivities (see “Cross-sensitivity compensation with OXOR-P”, page 156).
- THERMOR 3K: For the zero point calibration of the special version THERMOR 3K pure CO_2 is needed (see “Calibrating the special version THERMOR 3K”, page 157).

9.3.3 Test gases for sensitivity calibration

The “test gases” are used to calibrate the sensitivity. A test gas is a mixture of zero gas and one measuring component; in many cases test gas mixtures can be used with several measuring components if required.

Appropriate nominal values

The nominal values of a test gas are the true concentrations of the measuring components in the test gas.

- *Standard nominal values:* The nominal values can be within 10 ... 120 % of the physical measuring range end value – see `min. value` and `max. value` in the settings menu (see “Setting the nominal values for the calibration gases”, page 136). For an accurate calibration, the nominal values should be within 60 ... 100 % of the physical range end value. – This does not apply to the test gas for H_2O sensitivity calibration (see “Test gas feed for H2O sensitivity calibration”, page 152).
- *Nominal value for THERMOR:* The recommended test gas for sensitivity calibration of the THERMOR module is stated on the enclosure of the S700.
- *Nominal value for THERMOR 3K*: For the sensitivity calibration of special version THERMOR 3K, pure H_2 is needed (see “Calibrating the special version THERMOR 3K”, page 157).
- *Nominal value for OXOR-P* (Measuring component O_2): If the physical measuring range end value is 25 vol.%, atmospheric fresh air can be used as test gas (nominal value for O_2: 21 vol.%).

NOTE:
- ▶ *If separate information on required test gases has been delivered:* Observe this information with priority.
- ▶ *If a test gas has been changed (e.g. new test gas cylinder):* Remember to adjust the test gas nominal value in the S700.

Test gas mixtures

A test gas mixture is a mixture of zero gas and more than one measuring component. A test gas mixture can be used for simultaneous calibration of several measuring components. You could also use a test gas mixture for the calibration of several gas analyzers with different measuring components.

Test gas mixtures can be used in most applications. However, please note that test gas mixtures should *not* be used in the following cases:

- If the co-existence of the gas components could physically interfere with the analysis
- If the gas components could chemically react with each other
- If the mixture components would produce cross-sensitivity effects in the S700 for those measuring components which are to be calibrated, and these cross-sensitivity effects are not automatically compensated for
- If separate information was delivered with the analyzer which rules out the use of test gas mixtures.

Test gas criteria versus cross-sensitivities

- If the S700 is working with a cross-sensitivity compensation or with a carrier gas compensation, please observe the notes in see “Consequences of automatic compensations”, page 197.
- If the S700 has measuring components which have an H_2O cross-sensitivity which is not compensated for, please observe the notes in see “Calibrating “H2O cross-sensitive” measuring components”, page 156.

9.3.4 Simplifying the calibration gas requirements

Air as calibration gas

In some applications, it may be possible to use fresh atmospheric air for the calibration. Please note:

- If a sample gas cooler is used in the sample gas feed system and your S700 works with the internal H_2O cross-sensitivity compensation (see “Cross-sensitivity and gas matrix effect compensation”, page 26), then the air supplied for calibration should not be fed directly into the S700; it should be supplied via the sample gas cooler inlet (see “Correct feeding of the calibration gases”, page 129).
- If your S700 measures O_2 with the analyzer module OXOR-P, then air is not suitable as a zero gas, because air contains O_2. However, you could use air for the sensitivity calibration if this is within the measuring range of the analyzer.
- If your S700 measures O_2 with the analyzer module OXOR-E, then zero point calibrations are not required for the O_2 measurement (see “Analyzer modules for O2 measurement”, page 25). In this case, air can still be used for zero point calibration of the remaining measuring components: Set the nominal values for the zero gas so that `O2` zero point calibration is disabled (see “Setting the nominal values for the calibration gases”, page 136).

Calibration cuvette (UNOR/MULTOR)

The analyzer modules UNOR and MULTOR can be equipped with a “calibration cuvette” (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 24). In this case you will only need zero gas for the routine calibration. If air can be used as zero gas, then you will only need air for your routine calibrations.

OXOR-E + UNOR/MULTOR with calibration cuvette

If your S700 is equipped with these analyzer modules and the physical range end value for the O_2 measurement is at least 21 vol.%, then air can be used as the only calibration gas for routine calibrations. Use air for the zero point calibration of UNOR and MULTOR, and also for the sensitivity calibration for the OXOR-E (O_2 measurement). Activate the calibration cuvette for the sensitivity calibration of **UNOR/MULTOR**.

These steps are required to prepare an automatic calibration for this method:

1. Set the nominal value for the zero gas in such a way that zero point calibration for the O_2 measurement is disabled (nominal value for `O2`: “ `-.-` ” see “Setting the nominal values for the calibration gases”, page 136).
2. Use a test gas for sensitivity calibration of the O_2. Set the nominal value for this test gas as follows:
   - Nominal value for `O2: 20.9 vol.%` (O_2 concentration in atmospheric air).
   - Nominal value for all other measuring components = “ `-.-` ”.
3. Connect the switching output for this test gas with the switching output for the zero gas.
4. Disable the other tests gases from being used for calibration (see “Setting-up an automatic calibration”, page 135).
5. In the same menu, activate the calibration cuvette (nominal values for the calibration cuvette see “Calibration of the calibration cuvette (option)”, page 150).

Consequently an automatic calibration will run down in this way:

1. Air will be fed as `zero gas`: zero point calibration for UNOR/MULTOR.
2. Air will be fed as `test gas`: sensitivity calibration for OXOR-E.
3. `Calibration cuvette` is activated: sensitivity calibration for UNOR/MULTOR.

9.3.5 Correct feeding of the calibration gases

Inlet pressure for instruments without a built-in sample gas pump

▶ Feed the calibration gases into the analyzer at the same inlet pressure as the sample gas.

Inlet pressure for instruments with a built-in sample gas pump (option)

▶ Make sure that the built-in sample gas pump is switched off when calibration gases are fed into the analyzer. Available methods:
  – Switch off the pump manually each time when required (see “Switching the gas pump on/off”, page 81).
  – Set-up the automatic switch-off (see “Setting the nominal values for the calibration gases”, page 136).

▶ Feed the calibration gases at a slight overpressure (50 ... 100 mbar).

NOTE:
Excessive pressure can damage the built-in sample gas pump.
▶ For instruments with a built-in sample gas pump, make sure that the inlet pressure of calibration gases is properly limited (check the pressure regulator/reducer settings).

Gas flow

▶ Set the volumetric flow of the calibration gases identical to the volumetric flow of the sample gas (approximately).

Physical influences

The calibration gases should be fed under the same physical conditions as the sample gas. For example, if there are sample conditioning devices in front of the gas analyzer (filter, etc.), then the calibration gases should flow through these conditioning components before entering the gas analyzer.

▶ As a basic principle, feed the calibration gases under the same conditions as the sample gas.

▶ *If a sample gas cooler is used:* Let all calibration gases flow through the sample gas cooler before they reach the gas analyzer (scheme, see Fig. 3, page 37).
Exception: Zero gas for the calibration of the measuring component H_2O (see “Calibration of the H2O measurement”, page 151).

- Disturbing physical effects due to a sample gas cooler, see “Disturbing effects with a sample gas cooler”, page 200
- Notes on calibrations with a sample gas cooler, see “Calibrations with a sample gas cooler”, page 201

9.4 Manual calibration

9.4.1 Methods for calibration gas delivery

Manual calibration means that you control the calibration procedure. There are two methods to deliver the calibration gases to the analyzer:

– *Manual supply:* The supply of the calibration gases needs to be made manually (e.g. switching or opening external valves).
– *Automatic supply:* Install the external installations for calibration gas feed in the same way as for automatic calibrations (test gas cylinder and solenoid valves, which are connected to the switching outputs of the S700). When a certain calibration gas is selected in the course of the calibration procedure, it will be fed automatically to the analyzer.

+i Correct feeding of calibration gases, see “Correct feeding of the calibration gases”, page 129

9.4.2 Manual calibration procedure

Starting the procedure

▶ Select `main menu` → `calibration` → `manual procedure`.

`manual procedure`
 	
`1 zero gas 1`
`2 zero gas 2`
`3 test gas 3`
`4 test gas 4`
`5 test gas 5`
`6 test gas 6`
`7 calibr. cuvette`
`8 auto. starts`
	• When making a calibration, always start with a zero point calibration (`zero gas`).

Procedure for manual zero point calibration

`manual procedure`
 	
`1 zero gas 1`
`2 zero gas 2`
`3 test gas 3`
`4 test gas 4`
`5 test gas 5`
`6 test gas 6`
`7 calibr. cuvette`
`8 auto. starts`
	• Select the `zero gas` which has the correct nominal value programmed in the analyzer. If an automatic calibration gas feed is used, this gas must be available.

manual procedure zero gas 2 O2 0.00 CO2 0.00 NO 0.00 Start zero calibration with ENTER! Back : ESCAPE	← pre-set nominal values for the zero point ← (see "Setting the nominal values for the calibration gases", page 136) ← 1 If the zero gas delivery is not automatically controlled, feed the zero gas manually into the S700 now. 2 Press [Enter] to start the internal procedure.
manual procedure zero gas 2 Status: wait.. O2 0.27 vol.% CO2 -0.46 ppm NO 0.18 mg/m3 Please wait ... Break : ESCAPE	• After the start, the test gas delay time (see "Setting test gas delay time", page 138) runs down, indicated by wait.. • Then the actual values are measured (measuring..); at least for one period of the calibration measuring time which has been set (see "Setting the calibration measuring interval", page 139). – Information: The actual values displayed are drift-compensated according to the previous calibration (no "raw values"). 1 Wait until End: ENTER is displayed. 2 Wait until all the values are constant or remain fluctuating at a constant level. 3 Then press [Enter].
manual procedure zero gas 2 Status: measuring.. O2 0.31 vol.% CO2 -0.44 ppm NO 0.11 mg/m3 End : ENTER Break : ESCAPE	When you press [Enter], the S700 accepts the displayed values as the true actual values and calculates the differences from the nominal values (= drifts). You can abort the calibration by pressing [Esc].
manual procedure zero gas 2 O2 1.77 % CO2 -3.05 % NO 0.91 % Save: ENTER	← calculated values for absolute zero point drift[1] ← (for clarification, see "Display of drift values", page 80) ← • Press [Enter] to have the S700 compensate these drifts. • Press [Esc] if you do not want to accept these values (the previous zero point calibration will be kept).

[1] = total (accumulated) drift since the last drift reset (see "Drift reset", page 143) or the last basic calibration (see "Basic calibration", page 145).

Procedure for manual sensitivity calibration

CAUTION: Risk of wrong calibration
- Before making a sensitivity calibration, always make the corresponding zero point calibration.
- For sensitivity calibrations of the measuring component H_2O, perform the special procedure (see “Calibration of the H2O measurement”, page 151).

Otherwise the calibration will become wrong.

`manual procedure`
 	
`1 zero gas 1`
`2 zero gas 2`
`3 test gas 3`
`4 test gas 4`
`5 test gas 5`
`6 test gas 6`
`7 calibr. cuvette`
`8 auto. starts`
	• Select the `test gas` which matches the nominal value set in the analyzer. If an automatic calibration gas feed is used, this gas must be available.
	• If the analyzer module which is to be calibrated contains a calibration cuvette, you can also select `calibr. cuvette` here.

`manual procedure`	The remaining steps are the same as with a manual zero point calibration (see page 130). Deliver test gas instead of zero gas for this procedure.[1]

[1] If “calibration cuvette” is selected, continue feeding *zero gas* (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 24).

End of the calibration

When you have correctly calibrated the zero point and the sensitivity for all measuring components, the S700 is correctly calibrated.

To return to the measuring display:

1 Press `[Esc]` until the main menu appears.
2 Select the desired `measuring display` (see “Measuring displays”, page 74).

9.5 Automatic calibration

9.5.1 Requirements for automatic calibrations

These are the requirements for correct automatic calibrations:

1	An external valve system is installed to switch from sample gas to the calibration gases.	see “Designing the sample gas feed”, page 37
	This system is electrically connected to the related S700 switching outputs.	see “Configuration of the switching outputs”, page 97
2	The required gases are available (gas cylinders connected and sufficiently filled) and will be correctly fed.	see “Correct feeding of the calibration gases”, page 129
3	At least one automatic calibration is programmed.	see “Different automatic calibration routines”, page 134
4	The required calibration gases are correctly selected.	see “Setting-up an automatic calibration”, page 135
5	The nominal values for the calibration gases are correctly set.	see “Setting the nominal values for the calibration gases”, page 136
6	Test gas delay time and calibration measuring time are set with respect to the measuring system design.	see “Setting test gas delay time”, page 138 see “Setting the calibration measuring interval”, page 139
7	If the S700 should start autom. calibrations itself: The time interval and timepoint for the first start are set as desired.	see “Setting-up an automatic calibration”, page 135
8	If a control input is setup with the function “Service lock”: This control input is not activated.	see “Available control functions”, page 99

Some of these settings can be checked in the `information` menu (see “Displaying the automatic calibration settings”, page 140).

9.5.2 Different automatic calibration routines

Potential features

You can program four different automatic calibration routines where the following parameters can be set individually:

- calibration gases used
- start time for the automatic calibration
- time interval between automatic starts

All other settings for automatic calibrations (for example drift limit values) are valid for all the programmed routines.

Application options

- If you use an individual test gas for each automatic calibration (see “Setting the nominal values for the calibration gases”, page 136), you can set-up four independent automatic calibration routines.
- A particular measuring component can be calibrated more frequently than the others – for example, if the related analyzer module is working in a very sensitive measuring range. To do this, set-up a test gas with nominal values only for the selected measuring component (nominal values for all other measuring components = “ – ”) and configure a more frequent automatic calibration with this test gas.
- You could use the quick sensitivity calibration with the calibration cuvette (option for UNOR and MULTOR see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 24) more often than calibration with test gases. To do this, configure one of the automatic calibration routines so that only the calibration cuvette is used for the sensitivity calibration and that a shorter (more frequent) calibration interval is used.

9.5.3 Setting-up an automatic calibration

1 Call-up menu 631 (`main menu` → `settings` → `calibration` → `auto.calibration`).
2 Select which calibration routine (`1` ... `4`) you want to configure.
3 Make the following settings:

`auto.cal. mode`	`zero gas 1` ... `2`, `test gas 3` ... `6` and possibly `cal. cuvette` (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 24) will be shown, each with the option `yes` = will be used for this automatic calibration routine `no` = will not be used ● To change the status, press the related number key once. ● If “`no`” is set for all of the calibration gases (and the calibration cuvette), then this calibration routine is practically disabled and cannot be started. During the calibration procedure, the calibration gases (and the cal. cuvette) will be activated one after another in the displayed order.
`auto.cal. period`	Time interval (days /hours) in which this automatic calibration is periodically performed. The correct setting depends on the how much your S700 is drifting (depending on the application, the analyzer modules and the measuring ranges) and just how much drift from the measuring precision you can tolerate. ● Standard setting: 1 ... 7 days (`01-00` ... `07-00`) ● Settings for difficult applications (high measuring sensitivity) or high requirements (high measuring precision): 12 to 24 hours (`00-12` ... `01-00`). ● To disable automatic starts for this automatic calibration, set `00` days/ `00` hours. ● If the `auto.cal. day` was “today” and the `auto. cal. time` has already passed, then the `auto.cal. day` is automatically changed to the next day. ● Anyway, check the `auto.cal. day`, just to make sure.
`auto cal. time` `auto.cal. day`	Time and day when the next start of this automatic calibration will take place. ● Subsequent start times are determined by the `auto.cal. period` (see above). ● You can always change the next start time by re-selecting the `auto. cal.` time. The `auto.cal. period` will start anew after this calibration. If the time input is in the past, the analyzer will show `incorrect input`. If this happens when you have entered today’s date, please change the `auto.cal.time` so that the start time is in the future.

+i If the start time for an automatic calibration occurs while another calibration procedure is running, then this second calibration will be started when the running procedure is finished.

9.5.4 Setting the nominal values for the calibration gases

Function

It is essential for a correct automatic calibration that the programmed nominal values correspond to the actual concentrations of the measuring components in the calibration gases (see “Calibration gases”, page 125).

In the same menu, you can select to have the built-in gas pump (option) and the switching output “external pump” (if set-up) deactivated during the calibration gas feed.

> You must determine which of the test gases will be used during an automatic calibration (`auto.cal.mode`, see “Setting-up an automatic calibration”, page 135).

Setting

1 Call-up menu 632 (`main menu → settings → calibration → nominal values`).
2 Select a `zero gas` or `test gas`. The current settings will be displayed.

> For information on the menu item `cal. cuvette` (option), see “Calibration of the calibration cuvette (option)”, page 150.

3 Call-up `gas pump` and select if you want to have the built in pump (option) and the switching output “external pump” `on` or `off` when the calibration gases are fed into the analyzer.
4 Select one of the measuring components from the displayed list. In the following menu, enter its nominal value, i.e. the concentration of this measuring component in the selected test gas. *Attention:* If the test gas does not contain this measuring components, set the nominal value to “ `-.-` ” (press the backspace key) – not “ `0` ”.

CAUTION: Risk of wrong calibration
- Do not set the nominal value to “0” for a measuring component which is not included in the test gas. Set it to “`-.-`”.
- Do not forget to change the nominal values if a test gas has been changed (for example, when the gas cylinder has been replaced).

Otherwise the calibration will become wrong.

> When you set the nominal value to “ `-.-` ”, then the related measuring component will not be calibrated with this particular calibration gas. This setting can even be used when this measuring component is included in the calibration gas mixture.

9.5.5 Setting the drift limit values

Function

After each calibration, the S700 compares the current drift values for each measuring component to the drift limit values (see “Display of drift values”, page 80). The violation of a drift limit is indicated in two steps:

1 When a drift value equals 100 ... 120 % of the drift limit value, then the message S700 `SERVICE: zero drift` or `SERVICE: span drift` is displayed (+ the related measuring component). In addition, the Service LED is illuminated and the status output “fault” is activated.
2 When the drift value is more than 120 % of the drift limit value, then `FAULT: zero drift` or `FAULT: span drift` is displayed. The status output “failure” will also be activated and the **Function** LED shines red.

Information on the messages displayed, see “Status messages (in alphabetical order)”, page 186.

Application options

Drifts are caused, for example, by contamination, mechanical changes, or aging effects. It is not useful to perform more and more mathematical compensation for permanently increasing drift values. Instead, when an absolute drift has become very large, the related analyzer module should be inspected and re-adjusted (for example, a cleaning procedure and a basic calibration should be performed).

It is possible to setup an automatic monitoring for such cases by setting drift limit values for the measuring components – e.g. `20 %` (maximum value: `50 %`).

For monitoring the end of service life of the analyzer module OXOR-E, drift limit values can be used (see “Replacing the O2 sensor in the OXOR-E module”, page 180).

Setting

1 Call-up menu 633 (`main menu → settings → calibration → drift limits`).
2 Make the following settings:

`meas. component`	measuring component selected for the following settings
`zero drift limit`	desired drift limit value
`span drift limit`	

9.5.6 Ignoring an external calibration signal

Function

If the control inputs are setup with the function “auto. cal. start” (= start of automatic calibrations, see page 99), you can decide whether the S700 considers or ignores this input signal.

Setting

1 Call-up menu 634 (`main menu → settings → calibration → ext. cal. signals`).
2 Select the desired mode:

OFF	Input signal will be ignored
ON	Input signal can start an automatic calibration

9.5.7 Setting test gas delay time

Function

The test gas delay time determines how long the S700 must wait after switching to a calibration gas before the measured values can be used for calibration.

The delay time should correspond to the S700 response time (dead time + 100% time). To determine the response time, check for each measuring component how long it takes after switching to a calibration gas until the displayed measured value remains constant. The longest time should be used.

CAUTION: Risk of wrong calibration
If the test gas delay time is too short, then the calibration will be wrong.
▶ Better select a test gas delay time which might be longer than required than one that is too short.

- On the other hand, the test gas delay time should not be longer than necessary, in order to limit the time that the S700 is out of its measuring mode.
- At the end of the calibration procedure, after the analyzer has switched over to measure the sample gas again, the test gas delay time will run once again. This last waiting time is still a part of the calibration procedure – with all related consequences for the status messages and measured value outputs.
- The test gas delay time also applies to manual calibrations (see “Manual calibration”, page 130).

Setting

1 Call-up menu 635 (`main menu → settings → calibration → test gas delay time`).
2 Enter the test gas delay time (in seconds). – Standard value: 30 s.

9.5.8 Setting the calibration measuring interval

Function

During calibrations, the S700 starts (see “Setting test gas delay time”, page 138) the calibration measuring interval, where the measured values of the fed calibration gas are determined, after the “test gas delay time” sequence. For each measuring component, the average measured value within the calibration measuring time is calculated. These average values are used as the actual values.

The appropriate setting depends on two criteria:

- *Damping:* The calibration measuring time must be at least 150 ... 200 % of the damping time constant set (see “Setting damping (rolling average value computation)”, page 88 + “Setting dynamic damping”, page 89).
- *Measuring characteristics:* The calibration measuring interval must be long enough to make sure that averaging completely compensates all existing “noise” and measured value fluctuations. Check the analyzer modules to find the “worst” characteristic.

> The longer the calibration measuring time is, the more accurate the automatic calibrations will be.

> The calibration measuring time also applies to manual calibrations (see “Manual calibration”, page 130).

Setting

1 Call-up menu 636 (`main menu → settings → calibration→ cal. meas. time`).
2 Enter the calibration measuring time (in seconds).

9.5.9 Displaying the automatic calibration settings

The following can be checked via menu function:

- Nominal values of the calibration gases (see “Setting the nominal values for the calibration gases”, page 136);
- Starting times of the next automatic calibrations (see “Setting-up an automatic calibration”, page 135).

1 Call-up menu 41 (`main menu` → `calibration` → `auto. calibration`).
2 Select `auto. calibration` which you want to check.
3 Select `information`.

Information auto. calibration x 1 zero gas 1 2 zero gas 2 3 test gas 3 4 test gas 4 5 test gas 5 6 test gas 6 7 calibr. cuvette 8 auto. starts Enter digit	Select which parameter you want to check.

Information on zero gas, test gas or calibration cuvette (example).

Information Test gas 4 auto. calibration x	
O2 21.00	← nominal value for the 1st meas. component
CO2 450.00	← nominal value for the 2nd meas. component
NO -.--	← means: will not be taken into account
active yes	← `no` = will not be used for auto. calibrations
gas pump no	← status of the gas pump (see “Switching the gas pump on/off”, page 81)
Back : ESCAPE	*To exit this display:* Press [Esc].

Information on automatic starts of the automatic calibrations (example)

Information auto. starts auto. calibration x next start:	
Date : 16.09.04	← date and time when the next automatic
Time : 11:30	← calibration will start
Period : 02-00 DD-HH	← interval between automatic starts (days-hours)
Back : ESCAPE	*To exit this display:* Press [Esc].

9.5.10 Starting the automatic calibration procedure manually

CAUTION: Risk of wrong calibration
For automatic calibrations, some preparations are required.
- Only start an automatic calibration when all requirements are fulfilled (see "Requirements for automatic calibrations", page 133).

Some important settings can be checked in the `information` menu (see "Displaying the automatic calibration settings", page 140).

- Select `main menu` → `calibration` → `automatic cal.` → `automatic cal. x` → `manual control`.

`manual control`
` auto. calibration x`
`Press ENTER to start`
`an automatic`
`calibration now.`
`Press ENTER.`
 	
` Continue with ENTER`
` Break  : ESCAPE`
	If all requirements for an automatic calibration are fulfilled (see above), press [Enter] now.
	
	To abort the procedure, press [Esc].

`auto. calibration`
 	
`1 information`
`2 manual control`
	As long as the calibration procedure is running, `calibration running` is displayed on the status line.
	
	To abort a running calibration, select `manual control` again and confirm the abort with [Enter].

9.6 Displaying calibration data

Function

You can view the data which were determined and stored during the last calibration – individually for each measuring component.

Procedure

1 Select `main menu` → `calibration` → `show cal. data`.

show cal data 1 O2 2 CO2 3 NO	Select the desired measuring component.
-Z- -S- D: 31.08.04 31.08.04 T 11.30.00 11.31.30 N 0.00 300.00 R 0.68 300.09 Drift in % abs.: 0.23 -0.20 dif.: 0.02 -0.03 Back: ESCAPE	← zero point / sensitivity (Table heading) ← date at the end of the last calibration ← time at the end of the last calibration ← nominal values at the last calibration ← measured actual values at the last calibration ← absolute drift (explanation see “Display of drift values”, page 80) ← difference[1] in drift values to the previous cal. *To exit this display:* Press [Esc].

[1] = “percentage points” ($Dif_X = abs_X - abs_{X-1}$)

+i When a drift reset (see “Drift reset”, page 143) or basic calibration (see “Basic calibration”, page 145) was performed, no calibration data will be shown until a new calibration has been made. (This is also true for brand-new analyzers.)

+i Drift differences represent the ratio of test value versus nominal value. For the *sensitivity drift,* the drift difference is always computed with reference to the *smaller* value of the two values.
- *Example 1:* The test gas nominal value is 100 ppm.
  The test value during calibration was 98 ppm.
  Computed sensitivity drift = (102-100)/100 = +2.00 %
- *Example 2:* The test gas nominal value is 100 ppm.
  The test value during calibration was 102 ppm.
  Computed sensitivity drift = (98-100)/98 = –2.04 %

With this method, positive and negative physical drifts are calculated with a different mathematical loading. *Effect:* When a physical drift occurred and then changed back by the same amount, the calculated absolute drift is also back to the original value. Without the different mathematical loading, the absolute drift would differ from its previous value and thus no longer represent the actual physical state of the measuring system.

+i
- During each calibration, the S700 automatically checks whether a drift value is larger than the relevant drift limit value (see “Setting the drift limit values”, page 137). A malfunction message is displayed when this is the case.
- It is not recommended to continue with computed drift compensation when the drift values are increasing more and more. If an absolute drift becomes very large, the related analyzer module should be inspected and re-adjusted (for example, a cleaning procedure and a basic calibration should be performed). You can program limit values for automatic drift monitoring (see “Setting the drift limit values”, page 137).

9.7 Drift reset

Function

When a drift reset is made, the S700 cross-calculates the current “absolute drifts” (see “Display of drift values”, page 80) with the measuring parameters, and then the summation of the “absolute drifts” is restarted at “0.0” values. The drift reset allows you to begin the determination of “absolute drifts” at any time of your choice – for example, to check the analyzer’s drift over a certain period of time.

CAUTION: Risk of wrong calibration
If very high drift values are displayed after a manual calibration, then probably the test gases did not correspond to the programmed nominal values, or the test gas feed was faulty. And – although great discrepancies had been displayed – the calibration had been accepted by keypad entry.
- ▶ Never try to correct such a faulty situation by making a drift reset. Instead, try to calibrate the analyzer again carefully.

NOTE:
- A drift reset cannot be undone.
- A drift reset will discard the “history” of the “absolute drifts”.

NOTE:
- ▶ Do not use the drift reset to compensate for strong physical changes of an analyzer module – first make the required mechanical or optical adjustments.[1]
- ▶ Make a drift reset whenever an analyzer module has been cleaned or replaced.

[1] Such work should be carried out by a trained service technician.

Procedure

1 Call-up menu 73 (`main menu → service → drift reset`).
2 Enter the `Code`: [7] [2] [7] [5] [Enter]
3 Wait until `End: Enter` is displayed.
4 Press [Enter] to finish the procedure.

9.8 Special calibrations

9.8.1 Full calibration

Applies only to analyzers with the optional “internal cross-sensitivity compensation”.

When to perform a full calibration

For analyzers with “internal cross-sensitivity compensation” (option), perform a “full calibration procedure”, as described below, at the following recommended intervals:

- for analyzers measuring SO_2, NO, H_2O: every year
- for other measuring components: every two years

A full calibration should also be made if one of the following modifications has been made:

- adjustment, modification, or replacement of an analyzer module
- firmware update to software version 1.26 or 1.27

How to perform a full calibration

Perform two sets of calibrations in succession –

1. Perform a basic calibration (see page 145) for each of the S700 measuring components
2. Perform a calibration of cross-sensitivity compensations (see page 154).

– following these rules during these calibration procedures:

- *Use pure test gases:* Use an individual “pure” test gas (mixture of zero gas and relevant measuring component) for each measuring component. Do not use test gas mixtures.
- *Feed dry test gases:* Directly feed the calibration gases into the gas analyzer, not through a sample gas cooler (if existing).
- *H_2O calibration:* When the S700 is equipped with an analyzer module type MULTOR, which measures SO_2 as well as NO, also perform the calibration procedures for the measuring component H_2O.

9.8.2 Basic calibration

Need for a basic calibration

In the course of a basic calibration, both the analog and digital signal processing are measured and optimised anew. A basic calibration should be performed in the following situations:

- *After exchanging, readjusting or changing an analyzer module:* The analog amplification of the relevant measuring component must be optimized again because these actions usually change the physical characteristic of the analyzer module.
- *When the digital drift compensation has reached its limit:* The digital part of the measured value processing can be optimized again at any time with a drift reset, see “Drift reset”, page 143). However, the analog drift causes remain and must still be compensated. When the mathematical compensation is very large, then it might occur that the specified measuring precision is no longer maintained. This problem can be solved by performing a basic calibration, because this will include a reoptimization of the analog sections.

Principle procedure for a basic calibration

During a basic calibration, the following happens in principle:

1. The measuring signals of the analyzer module are checked, and the electronic amplification of the measuring signals is reoptimized to match.
2. The basic parameters of the mathematical measured value processing are recalculated (in the same way as during a drift reset, see page 143).

This happens individually for each measuring component and requires matching calibration gases. For a complete basic calibration, the procedure must be completed for each measuring component individually. You can run the procedure for certain measuring components only, for example, if the basic calibration is only required for a particular analyzer module.

Requirements for a basic calibration

To perform a basic calibration, you need the following:

- *Time:* Depending on the number, type and measuring range of the measuring components, the procedure can take approx. 20 to 120 minutes. During this time, the normal measuring function is deactivated.
- *Manual gas feed:* The calibration gases have to be fed manually into the S700 (e.g. via a hose connection or a manual valve).
- *Knowledge of the physical zero points:* Check the "span gas" information (see "Display of measuring ranges", page 77) for each measuring component for which a basic calibration is to be performed. Because either the zero gas or the test gas must correspond to this value during a basic calibration ((see Table 10).
- *Calibration gases:* For a basic calibration, an appropriate zero gas and test gas is required for each measuring component:

Table 10: Appropriate calibration gases for a basic calibration

"Span gas" value is	Nominal value for `zero gas`	Nominal value for test gas
... close or identical to the start value of the physical measuring range (standard).	identical to the "span gas" value	End value of the physical measuring range [1]
... close or identical to the end value of the physical measuring range (special).	Start value of the physical measuring range [1]	identical to the "span gas" value

[1] ± 20 % of the measurement span. The `min`/`max` values are set accordingly.

- When calibrating the measuring system of the S700 "from scratch", it may be useful to clean and/or readjust the analyzer modules before the basic calibration is performed.
- Modifications to the analyzer modules should only be made by trained service technicians or trained and authorised skilled persons. Otherwise the manufacturer's product guarantee will no longer be valid.

Special information applies for the special version THERMOR 3K (see "Calibrating the special version THERMOR 3K", page 157).

Starting a basic calibration

CAUTION: Risk for connected devices/systems

During a basic calibration, the measured value outputs will work in the following way:

- Measured value output OUT1 transmits the internal measuring signals which are measured during the procedure ("ADC values").
- Measured value outputs OUT2, OUT3 and OUT4 constantly show the last measured value which was measured before the basic calibration procedure began.

▶ Make sure that this situation cannot cause problems on connected devices.

NOTE:

If a basic calibration could not be completed successfully, then the S700 measuring function will be out of order.

▶ If you have any doubts during the basic calibration process, cancel the procedure by pressing [Esc]. This will keep the previous state.

▶ *Recommendation:* Backup the current data of the S700 before starting a basic calibration (see "Using an internal backup", page 109). This will allow you to repair the S700 if the basic calibration fails.

When a basic calibration is started, the S700 should already be in operation at least one hour, to insure that all internal temperatures are stable.

Special information applies for the special version THERMOR 3K (see "Calibrating the special version THERMOR 3K", page 157)

Call-up menu 74 (`main menu → service → basic calibration`).

Procedure for a single measuring component

1 Call-up `meas. component`.
2 Select the measuring component for which the basic calibration will be made.
3 Call-up `zero gas`.
4 Enter the nominal value of the zero gas (see Table 10, page 146).
5 Call-up `test gas`.
6 Enter the test gas nominal value (see Table 10, page 146).
7 When the nominal values have been correctly entered, select `measure`.
8 *Only for measuring components which are measured with the THERMOR analyzer module*: The following is now displayed (example):

H2 Deliver the physical zero gas and wait until the signal is stable. Actual value 0.234 Continue with ENTER	← THERMOR measuring component

a) Feed the calibration gas which corresponds to the “span gas” value for this measuring component.
b) Wait until the `Actual value` is nearly constant (±`0.1`).
c) Press [Enter].
The S700 now performs an electric adjustment of the THERMOR module (bridge adjustment); here, the `Actual value` is minimized. `Please wait` is displayed during the process (approx. 2 minutes).
d) Wait until `Continue with ENTER` is shown again. Press [Enter] to accept the adjustment.

9 A display message signals that the procedure is continued with the calibration gas which creates a higher measuring signal (usually the test gas). Press [Enter] to continue.
The following display will be like this (example):

CO2 30.000 vol.%	← measuring component and nominal value of the calibration gas
Enter CO2 test gas 30.000 vol.-% 0.000 vol.%	
Continue with ENTER	← only after sufficient waiting time as elapsed
0 = fixed amplific.	← *only for trained personnel* [1]

[1] Press [0] = current analog amplification will be fixed (will not be corrected). This can save time if the procedure had already been completely run and is now repeated after a short time. Not recommended for a completely new basic calibration.

10 Feed the displayed gas (*Attention:* The procedure starts with the *larger* nominal value.)
11 Wait until the gas has completely filled the internal gas path, replacing the previous gas (appropriate purge time).
12 Press [Enter].

Next, the S700 optimises the analog amplification of the measuring signal for the selected measuring component. The display will show (for example):

CO2 30.000 vol.%	← measuring component and nominal value of the calibration gas
CH4	← another measuring component
CO2 18559 341	← ADC value[1]; analog amplification stage[2] [3]
CO	← another measuring component
18,3 %	← progress of the internal procedure
Please wait ...	

[1] current digitized measuring signal (–32768 ... 32768)
[2] will automatically change and be adjusted during the procedure (0 ... 4095)
[3] values will only be shown for the selected measuring component

13 Wait until the display changes from `please wait ...` to the following:

When values are stable, start with Enter.	

14 Wait until the ADC value is “stable”, i.e. until it fluctuates around a constant average value (±50). Then press [Enter].

+i The ADC values displayed in this step (automatic amplification optimization) and in the next step (calibration measurement) may be different.

After this step, the S700 runs a calibration measurement with test gas (procedure takes 30 times longer than a normal measurement does). The completion of the procedure will be shown in %.

15 Wait until `Save: ENTER` is displayed. Press [Enter] to accept the displayed value. The following display will be like this (example):

Enter CO2 zero gas 0.000 vol.% Continue with ENTER	

16 Deliver the gas which is shown. Press [Enter].
The following display will be like this (example):

CO2 0.000 vol.%	
CH4	
CO2 1742	← ADC value [1]
CO	
When values are stable, start with Enter.	

[1] may rapidly change until the new gas has completely purged out the old gas

17 Wait until the ADC value is “stable”, i.e. until it fluctuates around a constant average value (±50). Then press [Enter].
Next, the S700 runs a calibration measurement with zero gas. The progress of the procedure will be shown in %.

18 Wait until `Save: ENTER` is displayed. Press [Enter] to accept the displayed value.

Now the S700 calculates the “linearisation values” (calibration curve): The variables of a basic mathematical function are modified until the optimum calibration function is found. The progress (%) and the number of iteration steps are displayed.

19 Wait until a display like this is shown:

`CO2 1.234`
 	
`Save: ENTER`
	← Measuring component; variation coefficient[1]

[1] represents the offset of the measured calibration values from the new calibration function. Values under `5.000` are typical; for difficult applications, the values can be larger.

20 Wait until `save: ENTER` is displayed.

> +i If the procedure was not successful, a malfunction message is displayed: under the word `FEHLER` (all menu languages), the calibration gas and the measuring component which could not be processed are displayed.
> ▶ *Clearance:* Terminate the procedure and repeat it carefully (check nominal values, feed calibration gases correctly, observe purge times).
> ▶ *If this does not help:* Contact the manufacturer's Customer Service for advice. Or restore the previous S700 values to use the analyzer in its previous state (can only be done if a data backup was made before starting the basic calibration, see “Using an internal backup”, page 109).

21 Press [Enter] to accept the displayed values for the basic calibration of the selected measuring component.

Repeat for the other measuring components

This will be necessary,
- if the S700 measures several measuring components and a *complete* basic calibration should be made;
- if the basic calibration is made for an analyzer module which measures *several* measuring components (MULTOR, FINOR).

22 `In the basic calibration` menu, select another `measuring component` and repeat the procedure for this new component, as described in “Procedure for a single measuring component”, page 147.

23 Repeat this until the “Procedure for a single measuring component” has been made for all desired measuring components.

> +i
> - When you leave the `basic calibration` function, a test gas delay time (see “Setting test gas delay time”, page 138) will run down before the measured value outputs display the current measured values of the sample gas.
> - If you have *terminated* a running basic calibration at any step of the procedure (using the [Esc] key), then the previous state of the basic calibration is kept.

Calibration with new cross-sensitivity correction

24 *Only for devices which work with “internal cross-sensitivity compensation” (option):* Perform a new, full calibration of the cross-sensitivity compensation after a basic calibration (see “Calibration of cross-sensitivity compensations (option)”, page 154).

9.8.3 Calibration of the calibration cuvette (option)

This information only applies for S700 with the option "calibration cuvette" (explanation, see "Calibration cuvette for analyzer modules UNOR and MULTOR", page 24).

Function

The calibration cuvette simulates the presence of a test gas – thus there are nominal values for the calibration cuvette, as there are for test gases. Each calibration cuvette has individual nominal values; these nominal values are first determined at the factory and saved in the S700.

We recommend to check these values approximately every 6 months, and correct if required. Practically this results in a calibration of the calibration cuvette. Because the S700 itself is used as the reference system, it must be "basic-calibrated" beforehand, using "real" test gases.

Procedure

1 Perform *one* of the following procedures:
   - Perform a calibration with test gases (not with the calibration cuvette). Zero point and sensitivity of the analyzer module UNOR and/or MULTOR must have been calibrated with test gases afterwards.
   - Perform a basic calibration (see page 145).

- If your S700 is equipped with several analyzer modules, you can set-up this calibration to include only the measuring components which are measured with UNOR and/or MULTOR.
- For the analyzer module MULTOR, you can also run the procedure for an individual measuring component.

NOTE:

Erroneous calibrations

▶ Proceed with the following steps only if one of the procedures in step 1 has successfully been performed just before.

Otherwise accumulated drift values could influence the nominal values of the calibration cuvette. This state could remain unnoticed and can only be eliminated by performing a basic calibration.

2 Feed zero gas into the S700.
3 Call-up menu 6327 (`main menu → settings → calibration → cal. cuvette`).
4 Select `check`.
   As long as `check` is selected, the calibration cuvette is moved into the optical beam of the analyzer module, and current test values for the UNOR/MULTOR measuring components are displayed. The bar graph display will show the internal modulation range.
5 Wait until all of the check values are constant.
6 Note down the displayed check value for each UNOR/MULTOR measuring component.
7 Press [Esc] to return to menu 6327.
8 Call-up the displayed measuring components one after another and, in the following menu, enter the noted check value as the new `status` value.

9.8.4 Calibration of the H_2O measurement

> This information only applies for the S700 with the measuring component H_2O (also see “Measuring component H2O”, page 198).

Special characteristics of the H_2O calibration

- The zero gas must be “dry”. If a sample gas cooler is used, the zero gas must not flow through the sample gas cooler.
- The required test gas is not available from gas cylinders – it must be produced at the analyzer’s location.
- If the H_2O measured value is only used for the internal cross-sensitivity compensation (see “Cross-sensitivity and gas matrix effect compensation”, page 26), then the calibration requirements are much easier – see the following notes.

Easier calibrations for H_2O cross-sensitivity compensation

If the H_2O measured value is only used for internal cross-sensitivity compensation, then the H2O measurement can work at a lower precision level than the other measuring components. This makes H_2O calibrations easier in the following way:

- You can select much longer calibration intervals for H_2O than for the other routine calibrations. Recommended interval: 1 year.
- It is not required that the zero gas is absolutely “dry”. Small residual H_2O concentrations are allowed (500 ppm H_2O).
- It is not required that the nominal value for the H_2O test gases exactly meet the real concentration; nominal values that “roughly” meet the actual values are sufficient. The important criterion is that the physical conditions in the gas supply system should be identical during both measuring operation and calibration and are kept constant during operation; this does especially apply to sample gas coolers.

Zero gas for H_2O calibrations

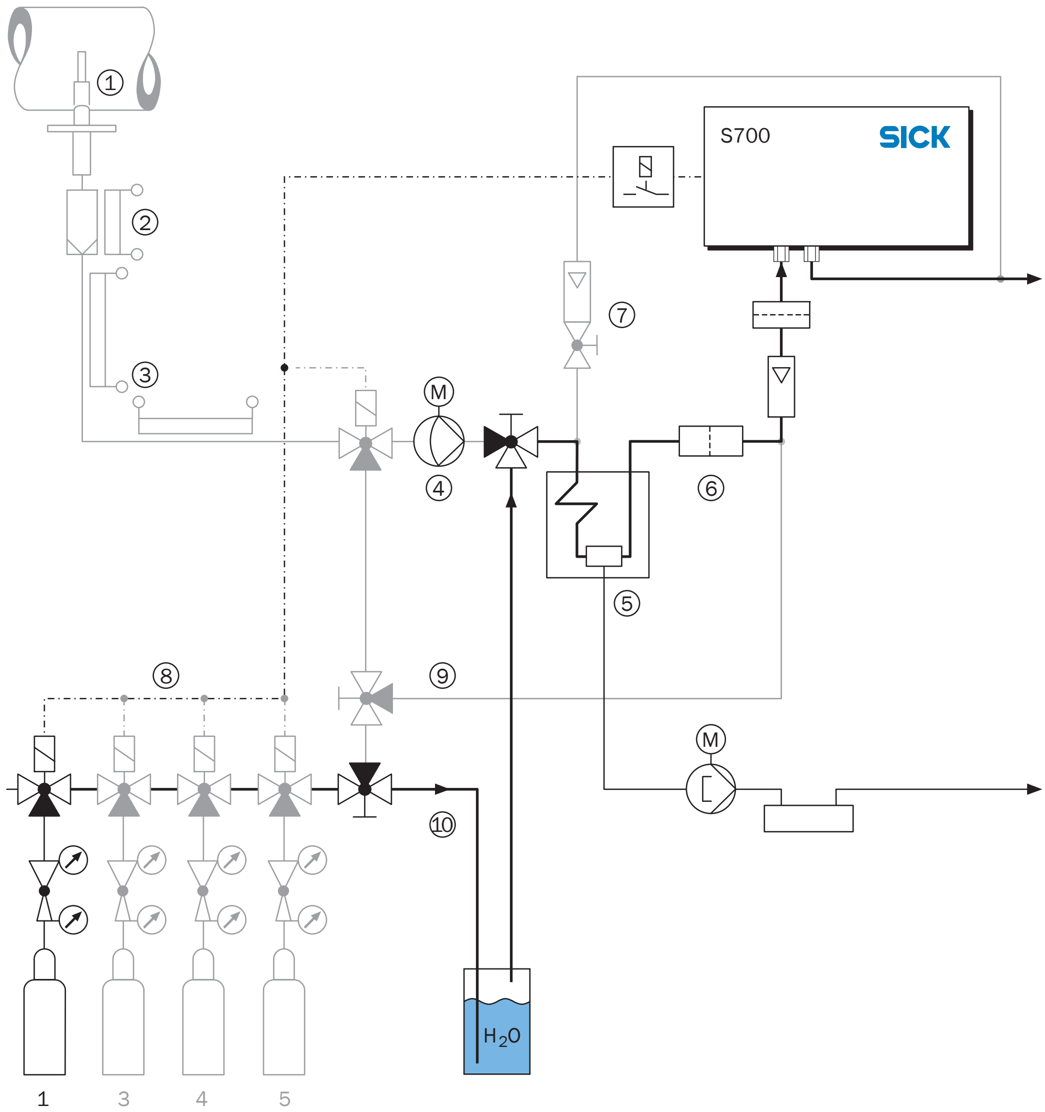
The zero gas must not contain any H_2O, which means that it must be absolutely “dry”. To meet this requirement, the zero gas should be supplied from the gas cylinder *directly* into the analyzer and must *not* flow through a sample gas cooler. You may want to use a bypass line, if available (installation notes, see “Designing the sample gas feed”, page 37). If atmospheric air is used as the zero gas, the air must be dehumidified before being fed into the analyzer (methods, see “Calibration of cross-sensitivity compensations (option)”, page 154).

Test gas for H_2O calibrations

Create the test gas for a H_2O sensitivity calibration as follows (see Fig. 22, page 152):

1. Let nitrogen (zero gas) flow through water – for example through a wash bottle or a vessel with water-saturated cotton wool. Water temperature: 15 ... 30 °C (room temperature).
2. Let the vapor-saturated gas flow through a sample gas cooler (cooler temperature: 2 ... 6 °C). After the gas has run through the cooler, the H_2O concentration in the gas corresponds to the vapor pressure at the cooler temperature (see Table 12, page 153).
   – Feed this gas during the H_2O sensitivity calibration.

Fig. 22: Test gas feed for H_2O sensitivity calibration



Nominal values of the H_2O calibration gases

Program the following nominal values for one zero gas and one test gas each for the H_2O sensitivity calibration (see “Setting the nominal values for the calibration gases”, page 136):

Table 11: Nominal values for H_2O calibration

	nominal value ...	
	... for `H2O`	... for all other measuring components
... for zero gas	`0.00`	“`–.–`” (= will not be calibrated) or a matching nominal value (if required)
... for test gas	(see Table 12	

Table 12: Nominal values for H_2O test gas

Cooler temperature	2 °C	3 °C	4 °C	5 °C	6 °C	7 °C	8 °C	9 °C
H_2O nom. value [ppm]	6960	7470	8010	8590	9210	9870	10580	11320

The H_2O measurement has been calibrated at the factory. This fact can be used: As long as your S700 is brand-new, the nominal value of H_2O test gas can be determined by having it *measured* once by the S700. You can use the measured H_2O value as the nominal value as long as there is no change in the sample gas cooler.

Procedure

1 Feed “dry” zero gas into the S700, as explained above.
2 Perform a manual zero point calibration (see “Manual calibration procedure”, page 130) using the programmed `zero gas`.
3 Deliver the test gas for H_2O sensitivity calibration to the S700, as explained above.
4 Perform a manual sensitivity calibration using the programmed `test gas`.

9.8.5 Calibration of cross-sensitivity compensations (option)

This information is only valid for S700 analyzers equipped with the option “internal cross-sensitivity compensation” (see “Cross-sensitivity and gas matrix effect compensation”, page 26).

Function

While usual calibrations will calibrate the zero point and sensitivity of a measuring component, it is possible to make special calibrations which include the re-calibration of the internal cross-sensitivity compensations. During such calibrations, the S700 will additionally check for cross-effects which occur in the analysis of all those measuring components which are associated for cross-sensitivity compensation, and then will re-adjust the compensations accordingly. The corresponding menu function is called “calibration with correction”.

Calibrations “with correction” may be more demanding than normal calibrations (because of more exacting requirements for the calibration gases), but they only need to be done at long time intervals. Recommended calibration periods are:

– For the measuring components SO_2, NO, H_2O: 1 year
– For other measuring components: 2 years

Required calibration gases

- For “calibrations with correction”, pure test gases should be used, which means that each test gas consists of the zero gas and only one measuring component. You may also use test gas mixtures which include more than one measuring component if it is sure that the mixed components do not produce any cross-effects.
- For analyzers with calibration cuvette (see “Calibration cuvette for analyzer modules UNOR and MULTOR”, page 24), it is required to use test gases. This calibration procedure does not allow to use the calibration cuvette.
- For analyzers with internal H_2O cross-sensitivity compensation, all calibration gases must be “dry”, i.e. they must not contain any measurable H_2O concentration (exception: test gas for H_2O sensitivity calibration; see “Calibration of the H2O measurement”, page 151). To meet this requirement, the calibration gases should be supplied from the gas cylinders *directly* into the analyzer and must *not* flow through a sample gas cooler. You may want to use a bypass line, if available (installation notes, see “Designing the sample gas feed”, page 37). – If atmospheric air is used as the zero gas, the air must be dehumidified before being fed into the analyzer.

  Some methods for gas dehumidification are:
  – Let the calibration gases flow through a low-temperature gas cooler.
  – Let the calibration gases flow through a dehumidifying agent, for example SilicaGel. Please note that the agent should not affect the other gas components.

Procedure

1 Call-up menu 696 (main menu → settings → [9] → [code] → cal. w/ correction).

> In analyzers equipped with software version 1.26 (or previous), this function is located in menu 637 (main menu → settings → calibration → cal. w/ correction).

2 Set the function status to ON.

3 Perform a calibration procedure as usual – however:
   - Use “pure” test gases or “cross-effect free” test gas mixtures.
   - For analyzer modules UNOR/MULTOR with calibration cuvette (option), do not use the calibration cuvette in this calibration procedure; use test gases instead.
   - With internal H_2O cross-sensitivity compensation: Use H_2O-free (“dry”) calibration gases and do not feed the calibration gases through a sample gas cooler during this calibration (except for H_2O sensitivity calibration; see “Calibration of the H2O measurement”, page 151).

4 When the calibration procedure has been finished, set the “calibration with correction” function status to OFF.

▶ Make sure that during measuring operation and routine calibrations, the cal. w/correction function is set to OFF.

9.8.6 Calibrating “H_2O cross-sensitive” measuring components

If all of the following criteria apply to your S700:

- the sample gas contains H_2O
- an internal H_2O cross-sensitivity compensation is not active
- at least one measuring component (for example: SO_2, NO) has a cross-sensitivity against H_2O and this effect is large enough to interfere with the specified measuring precision
- a sample gas cooler is used

you must ensure that the calibration gases contain the same H_2O concentration as the sample gas when they reach the gas analyzer during calibration (of the “cross-sensitive” measuring components).

You can achieve this as follows:

1 First, produce a high H_2O gas concentration in the calibration gases. To do this, install a suitable vessel in the gas path, filled with water, and make the calibration gases bubble through the vessel.
2 Feed the calibration gases from the water vessel through the sample gas cooler into the gas analyzer. The sample gas cooler will reduce the H_2O concentration to the same level as in the sample gas.

9.8.7 Cross-sensitivity compensation with OXOR-P

Only applies for S700 with the analyzer module “OXOR-P” (see “Analyzer modules for O2 measurement”, page 25).

Physical interference effect

If the zero point of the OXOR-P module is calibrated with nitrogen and the sample gas consists mainly of other gases with considerable paramagnetic or diamagnetic susceptibility, then major measurement errors might occur. In this case, the S700 could display a measured value for O_2 even when the sample gas does not contain any oxygen.

Compensation methods

There are three methods to compensate for this interference effect:

- *Adapted zero gas:* Use the corresponding “interfering gas” or an O_2-free gas mixture representing the average sample gas composition as zero gas. Because the zero point is calibrated “under sample gas conditions”, the cross-sensitivity is considered in the calibration.
- *Manual compensation:* Use normal zero gas to calibrate the zero point and do not set the setpoint value for zero gas to “0” but to a value that exactly counters the cross-sensitivity effect. In this way, the zero point is constantly shifted, which compensates for the cross-sensitivity effect.
- *Automatic compensation:* The S700 measures the interfering gas component(s) simultaneously with own analyzer modules and compensates the cross-sensitivity effects with the help of these measured values (“internal cross-sensitivity compensation”, see “Cross-sensitivity and gas matrix effect compensation”, page 26).

9.8.8 Calibrating the special version THERMOR 3K

Only applies for S700 with the analyzer module THERMOR 3K (see "Special version "THERMOR 3K"", page 194).

Calibration restrictions

- It is always required to calibrate both the zero point and the sensitivity (see "Introduction to the calibration of the S700", page 123).
- Nominal values for calibration gases (see "Calibration gases", page 125 / "Setting the nominal values for the calibration gases", page 136) are fixed and cannot be changed:

Zero gas	(for zero point calibration)	100 vol.% CO2	(pure CO_2)
Test gas	(for sensitivity calibration)	100 vol.% H2	(pure H_2)

Safe calibration procedure

WARNING: Risk of explosion caused by hydrogen (H_2)
Gas mixtures of hydrogen + oxygen or hydrogen + air are highly explosive.

- ▶ Do not mix hydrogen and oxygen.
- ▶ Do not mix hydrogen and air.
- ▶ Never feed hydrogen into a gas path which is filled with oxygen or air.
- ▶ Never feed oxygen or air into a gas path which is filled with hydrogen.
- ▶ Make sure that those gas paths which are alternatively used for hydrogen and oxygen/air are purged with a "neutral" gas (for example, N_2 or CO_2) before the other gas is fed.

Maintain this sequence for safe feeding of the calibration gases:

1. *Before the calibration:* Feed the test gas "pure CO_2" into the sample gas path of the S700 (to remove air from the gas path).
2. Let the zero point calibration run with this gas.
3. Feed "pure H_2" as the test gas.
4. Let the sensitivity calibration run with this gas.
5. *After the sensitivity calibration:* Feed CO_2 again until H_2 is completely discharged.

Basic calibration

- Three calibration gases are required for the basic calibration (see page 145):

`Physical zero gas`	air (fresh atmospheric air)
`Zero gas`	100 vol.% CO2 (pure CO_2)
`Test gas`	100 vol.% H2 (pure H_2)

- In the basic calibration procedure, the measuring component selection is not required. The basic calibration will automatically be made only for the measuring component `H2-CO2`. The S700 automatically calculates the values for the other measuring components.

9.9 Validation for UNOR/MULTOR

Only applies for S700 with the analyzer module UNOR or MULTOR with calibration cuvette (see "Calibration cuvette for analyzer modules UNOR and MULTOR", page 24).

Function

If the S700 is equipped with an UNOR or MULTOR analyzer module and a calibration cuvette, you can use the `Validation` function to quickly check whether the measuring system is functioning correctly. During a validation, the S700 simulates a calibration procedure with test gases, but, however, uses the calibration cuvette instead of test gases. At the end of the procedure, real measured values are displayed which should be compared with the nominal values (previously displayed); if the values are similar, the UNOR/MULTOR module is functioning correctly.

The procedure requires to feed in zero gas.

A validation does not change the calibration.

Procedure

1 Call-up menu 44 (`main menu → calibration → validation`).
2 Feed in zero gas (see "Zero gases (calibration gases for the zero point)", page 126). The switching output zero gas path 1 is automatically activated; when the zero gas feed is controlled via this switching output, the zero gas automatically flows in.
The nominal values of the calibration cuvette are displayed (example):

Display	
`calibration 44` `Validation`	
`CO 1598.9 ppm`	← nominal values
`NO 3997.1 ppm`	←
`Validation` `Start with ENTER!`	Please note down these values or keep them in mind.

3 Press [Enter] to start the automatic validation procedure. – The display will show the measured values of all measuring components (example):

Display	
`Status: Measuring`	
`CO 1540.2 ppm`	← actual values
`NO 3409.4 ppm`	←
`SO2 702.5 ppm`	←
`H2O 26.5 ppm`	←
`Please wait ...`	

4 Wait until `Back: ESCAPE` is displayed.
5 Compare the actual values with the nominal values. If the values are similar, then the UNOR/MULTOR analyzer module is working correctly.
6 Press [Esc] to leave the procedure.

10 Remote control with “AK protocol”

Only applies for S700 with option “limited AK protocol”.

10.1 Introduction to the remote control with “AK protocol”

The “AK protocol” is a software specification for digital interfaces which has been defined by the German automobile industry. The S700 option “limited AK protocol” provides some remote control functions which are related to this specification.

Using the “limited AK protocol” remote control commands, you can

- activate and deactivate the “limited AK protocol” remote control mode
- call-up the current device status of the S700
- remotely control and set some of the calibration functions

10.2 Technical basics

10.2.1 Interface

Interface #1 is used for the remote control (pin assignment, see “Plug connector X2 (interfaces)”, page 65). The standard interface parameters are:

Baud rate	9600
Data bits	8
Parity	None
Stop bits	1

Setting, see “Digital interface parameters”, page 101

10.2.2 Complete command sequence (command syntax)

A complete remote control command consists of the following characters:

- First character = character STX (02hex).
- Second character = ID character [AK-ID] of the S700 (see “Setting the ID character”, page 105).
- The [AK-ID] is followed by the 4-character command plus additional parameters (if required). There must be a space character (20hex) between the command and each parameter.
- Last character = character ETX (03hex).

Byte	Contents
1	character STX (02hex)
2	[AK-ID]
3 ... 6	four command characters
7 ... (n-1)	space character + parameter, if required
n	character ETX

10.3 Command types

There are 3 types of remote control commands:

First command character	General function	Available
A	Read data from the S700	Always (no preparation required)
E	Change settings in the S700	When remote control is activated (see “General commands”, page 162)
S	Start S700 procedure	

10.4 Reply to a received command

The S700 checks every command it receives and sends a “reply”.

10.4.1 Status character

Part of the reply is a status character which gives information about the internal status of the S700:

- Normally the status is 0.
- The status will increase by 1 for any of the internal faults:
  `FAULT: gas flow`
  `FAULT: chopper`
  `FAULT: step motor`
  `FAULT: temperature`

Other status or malfunction messages do not influence the status character. To obtain complete status information, you can use the remote control command AFLT (see “Status reading commands”, page 162).

10.4.2 Normal reply

Command status	Reply	
The received command will be executed.	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character] [1]
	Byte 9 ... n	[space]+[parameter]
	Byte n+1	ETX

[1] see “Status character”, page 160.

10.4.3 Reply to an erroneous command

Command status	Reply	
The [AK-ID] character in the received command does not match the ID character of this S700 (see “Setting the ID character”, page 105).	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	????
	Byte 7	[space character]
	Byte 8	[status character] [1]
	Byte 9 ... n	[space]+[parameter]
	Byte n+1	ETX
The received command began with E or S, but the remote control is not activated (see “General commands”, page 162).	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	[space character]
	Byte 10 ... 13	SMAN
	Byte 14	ETX
The received command cannot be executed at this time. (Example: While an automatic calibration is running, the calibration gas switching outputs cannot be activated via remote control.)	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	[space character]
	Byte 10 ... 11	BS
	Byte 12	ETX
The received command does not match the command syntax.	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	[received command]
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	[space character]
	Byte 10 ... 11	SE
	Byte 12	ETX
The received command is not defined.	Byte 1	STX
	Byte 2	[AK-ID]
	Byte 3 ... 6	????
	Byte 7	[space character]
	Byte 8	[status character]
	Byte 9	ETX

[1] see “Status character”, page 160.

10.5 Remote control commands

10.5.1 General commands

Command	*Activating the remote control*
Function	After this command, the S700 will execute all remote control commands which begin with S and E. ("A" commands can be executed without this activation.)
Command syntax	SREM
Transmitted reply	SREM [status character] (= command was executed)

Command	*De-activating the remote control*
Function	After this command the S700 will only execute control commands beginning with A or the command SREM. The S700 will reject other commands which begin with S or E.
Command syntax	SMAN
Transmitted reply	SMAN [status character] (= command was executed)
	SMAN [status character] SMAN (= SREM is not activated)

Command	*Abort procedure*
Function	The S700 terminates the procedure which is currently running (for example, calibration) and controls the switching outputs in such a way that sample gas is fed to the analyzer.
Command syntax	SBRK
Transmitted reply	SBRK [status character] (= command was executed)
	SBRK [status character] SMAN (= SREM is not activated)

Command	*Read command status*
Function	The S700 sends information about the S-command which has just been executed.
Command syntax	ASTA
Transmitted reply	ASTA [status character] [actual command]
Reply examples	AKOW 0 SMGA (= measuring)
	AKOW 0 SSG3 (= last command was SSG3)
	AKOW 0 SATK SNGA (= automatic calibration is running, zero gas is switched on)

10.5.2 Status reading commands

Command	*Read measuring components and measuring ranges*
Function	The S700 sends the internal name of a measuring component and the related physical measuring range, user-selectable for a single component or for all components.
Command syntax	AKMP Kx x = 1 ... 5: number of the desired measuring component x = 0: all measuring components
	AKMP = same function as AKMP K0
Transmitted reply	AKMP [status character] [x] [y] [x] = identification of the measuring component [y] = end value of the related physical measuring range

Command	Read measured values
Function	The S700 sends the current measured value for a single component or for all measuring components.
Command syntax	AKONx x = number of the desired measuring component x = 0 or no x: all measuring components
Transmitted reply	AKON [status character] [x] [mv] ([x2] [mv2] [x3] [mv3] ...)
	AKON [status character] **#** (= currently no measured value)

Command	*Read device status*
Function	The S700 sends a coded status message.
Command syntax	AFLT
Transmitted reply	AFLT [status character] 00100001 00001000 00000000 ... (8 blocks of 8 Bits, each block separated by a space character)

Command	*Read serial number*
Function	The S700 sends its own serial number (see "Display of device data", page 79).
Command syntax	AGNR
Transmitted reply	AGNR [status character] [x] [x] = serial number

Command	*Read menu language*
Function	The S700 sends a character as identification for the selected menu language (example: E = english).
Command syntax	ASPR
Transmitted reply	ASPR [status character] [character]

10.5.3 Calibration commands

Command	*Read time interval*
Function	The S700 sends the time interval which has been set for a particular function. (Currently this is only available for “calibration” = start command SATK.)
Command syntax	AFDA [function start command]
Transmitted reply	AFDA [function start command] [Value1] [Value2] ...
	AFDA [function start command] SE (= there is no time interval for this function or the command was partially incorrect.)

Command	*Set time interval*
Function	Set test gas delay time (see page 138) or calibration measuring time (see page 139).
Command syntax	EFDA SATK [x] [y] [x] = test gas delay time = 10 ... 180 (seconds) [y] = calibration measuring time = 2 ... 600 (seconds)
Transmitted reply	EFDA [status character] (= command has been executed)
	EFDA [status character] SMAN (= SREM is not activated)
	EFDA [status character] SE (= command was partially incorrect)

Command	*Read the settings for the calibration gases*
Function	The S700 sends the nominal values and the pump status which are set for a particular calibration gas.
Command syntax	AKNx x = 1 ... 2 = desired zero gas
	AKPy y = 3 ... 6 = selected test gas
Transmitted reply	AK... [status character] [pump status] [SW1] [SW2] [SW3] ... [SW...] = nominal value of the measuring component in % full scale of the physical measuring range (NO = “ -.- ” is set)

Command	*Read the settings for the calibration cuvette*
Function	The S700 sends the internal nominal values for the calibration cuvette.
Command syntax	AKKK
Transmitted reply	AKKK [status character] [pump status] [SW1] [SW2] [SW3] ... [SW...] = nominal values for the measuring components (internal units)
	AKKK [Status characters] SE (= there is no calibration cuvette in the analyzer)

Command	*Set values for calibration gases*
Function	Sets the nominal values and the pump status for the calibration gases. ● The nominal values are only valid for the first automatic calibration (see “Different automatic calibration routines”, page 134). ● The nominal values must be set for each calibration gas and for each measuring component which will be used during the first automatic calibration. ● A nominal value is either a value in % of the physical measuring range or NO. NO means that this test gas will not be used for sensitivity calibration for a particular measuring component (equals the menu setting “ -.- ”). ● If all of the nominal values are set to NO, then this calibration gas will not be used for an automatic calibration. ● The [pump status] determines if the gas pump (built-in or controlled by the S700) will remain switched on during delivery of the calibration gas to the analyzer. ● This command cannot be use for an H_2O calibration because a special procedure must be used for the H_2O sensitivity calibration (see “Calibration of the H2O measurement”, page 151).
Command syntax	EKNx [pump status] [SN1] [SN2] ... [SNn] x = 1 or 2 (for zero gas x) [SN...] = –20.0 ... 80.0 or NO
	EKPx [pump status] [SP1] [SP2] ... [SPn] x = 3, 4, 5 or 6 (for test gas x) [SP...] = 10.0 ... 120.0 or NO
	[pump status] = ON or OFF n = total number of measuring components
Transmitted reply	EK... [status character] (= command was executed)
	EK... [status character] SMAN (= SREM is not activated)
	EK... [status character] SE (= command was partially incorrect)

Command	*Start an automatic calibration*
Function	The S700 runs an automatic calibration according to the settings for the first automatic calibration.
Command syntax	SATK
Transmitted reply	SATK [status character] (= command was executed)
	SATK [status character] SMAN (= SREM is not activated)
	SATK [status character] BS (= command cannot be executed because another procedure is running)

Command	*Read calibration results*
Function	The S700 sends the “absolute drifts” (see “Display of drift values”, page 80) for a particular measuring component. The values have been calculated during the last calibration.
Command syntax	AKOW Kx x = 1 ... 5 = number of the desired measuring component
Transmitted reply	AKOW [pump status] [x] [y] [x] = zero point drift (%) [y] = sensitivity drift (%)

Command	*Measure a calibration gas*
Function	The S700 controls the switching outputs for gases in such a way that the desired calibration gas will be entered into the analyzer and measured in the normal measuring mode.
Command syntax	SNGx x = 1 ... 2 = desired zero gas
	SPGx x = 3 ... 6 = desired test gas
Transmitted reply	S...G... [status character] (= command was executed)
	S...G... [status character] SMAN (= SREM is not activated)
	S...G... [status character] BS (= command cannot be executed because another procedure is currently running)

10.5.4 Measuring mode commands

Command	*Deliver sample gas*
Function	The S700 controls the switching outputs in such a way that the sample gas will be fed to the analyzer and the analyzer is in its normal measuring mode.
Command syntax	SMGA
Transmitted reply	SMGA [status character] (= command was executed)
	SMGA [status character] SMAN (= SREM is not activated)
	SMGA [status character] BS (= command cannot be executed because another procedure is currently running)

10.5.5 Device identification commands

Command	*Read device identification*
Function	The S700 sends the programmed device identification.
Command syntax	AKEN
Transmitted reply	AKEN [status character] [device identification]

Command	*Set the device identification*
Function	The S700 saves the entered device identification. This [device ID] can consist of a maximum of 40 ASCII characters.
Command syntax	EKEN [device identification]
Transmitted reply	EKEN [status character] (= device ID has been saved)
	EKEN [status character] SE (= Command was partially incorrect)
	EKEN [status character] SE (= Command was partially incorrect)

10.5.6 Temperature compensation commands

Command	*Read the temperature compensation status*
Function	The S700 reports if the temperature compensation has been activated for a particular measuring component.
Command syntax	ATMP Kx x = 1 ... 5 = number of the desired measuring component
Transmitted reply	ATMP [status character] x ON (= temp. compensation is active)
	ATMP [status character] x OFF (= temp. compens. is not active)
	ATMP [status character] SE (= command was partially incorrect)

Command	*Switch on/off the temperature compensation*
Function	Activate or deactivate the temperature compensation for a particular component.
Command syntax	ETMP Kx [a] x = 1 ... 5 = number of the desired measuring component [a] = ON (activate) or OFF (deactivate)
Transmitted reply	ETMP [status character] (= Command was executed)
	ETMP [status character] SMAN (= SREM is not activated)
	ETMP [status character] SE (= command was partially incorrect)

11 Remote control with Modbus

11.1 Introduction to the Modbus protocol

Function

Modbus® is a communication standard for digital control systems, used to establish a connection between a “master” device and a number of “slave” devices. The Modbus protocol only defines the communication commands not their electronic transfer which means it can be used for different digital interfaces (e.g. RS232, RS422, RS485). The Modbus standard was originally developed by the MODICON company for use with their interface controller chips; now it is a widely-used industrial application.

Versions

There are two Modbus transmission versions:

- *ASCII transfer mode:* Two ASCII characters (2 characters each with 4 bits) are sent in one byte (8 bits). It allows pauses between message characters (up to 1 second) without causing an error.
- *RTU transfer mode:* Two hexadecimal characters are sent as two characters each with 4 bits. The RTU mode can be faster.

Command structure

Address (address)	Function (function)	Data (data)	Check sum (check sum)

- The device address is set individually for each connected device.
- Function codes are specified by the Modbus standard. For example, there are functions used to trigger data output from the slave device (Read) and to change status or settings in the slave (Force).
- The function data contain the additional information required to perform the function. This information is device-specific, which means that the data must be specified by the manufacturer. The function code and function data pair form the command that the addressed slave should perform.
- The check sum is used to validate the transmitted data. The check sum is calculated by both the transmitting and the receiving device. If the results are identical, the data transmission was correct.

Slave’s Respond

Normally, the slave will respond to a command by sending an echo, with the same Function code, and with the Data containing the requested information. For error messages, the Function code is modified, and the Data contain an error code.

+i For more information on the Modbus protocol, visit the Modbus Internet website: http://www.modbus.org

11.2 Modbus specifications for the S700

Modbus functionality

- The S700 works as a slave device.
- The S700 uses the RTU mode for input and output transmission.
- The S700 responds to an input command immediately after the last command character has been received, without any delay. This is an exception from the “Modicon Modbus Reference Guide” which specifies a “Silent Interval” in the RTU mode of 3.5 character times after each command.

Allowable Modbus parameters

▶ With a Baud rate of 9600 Baud, maintain the following Modbus parameters:

Slave response time:	200 ms
Delay between polls:	200 ms
Scan rate:	500 ms

▶ Set longer times for lower Baud rates.

! Data transmission errors might occur with lower values.

The S700 takes approximately 0.5 seconds to generate a new measured value. When the S700 measures two measuring components, new measured values are created at intervals of approx. 1 second. It is probably not necessary to request measured values at shorter intervals.

11.3 Installation of a Modbus remote control

11.3.1 Interface

Interface #1 is used for the remote control (pin assignment, see “Plug connector X2 (interfaces)”, page 65). Permitted interface parameters:

Baud rate:	maximum 28800
Data bits:	8
Parity:	even/odd/none (as required)
Stop bits:	1

Settings, see “Digital interface parameters”, page 101.

11.3.2 Electrical connection

Connecting a single slave device

The Modbus functions can even be used with a simple direct interface connection, as shown on the left part of “Remote control with “AK protocol”” (see page 159). In this way, a single S700 can be connected to a master device – for example, for a test.

Connecting several slave devices (BUS mode)

If several S700 analyzers are to be controlled by a master device, a BUS system must be installed using RS232C/BUS converters, as shown on the right part of “Remote control with “AK protocol”” (see page 159). Other BUS systems can be used instead of RS422; for example, RS485.

11.3.3 Making the necessary settings in the S700

1. Set-up the interface parameters on interface #1 to match those on the connected BUS converter or master device (see “Digital interface parameters”, page 101).
2. *For operation with Bus converters:* Activate “RTS/CTS protocol” (see “Creating an interface connection”, page 203).
3. Set-up the installed electrical connection (see “Setting the installed connection”, page 106).
4. Set-up an individual identification character for each of the connected gas analyzers (see “Setting the ID character”, page 105).
5. Activate `AK-ID with MODBUS` (see “Activating the ID character / Activating Modbus”, page 106).

When using BUS converters:

- ▶ Make all the remote control settings ***identical*** in all the connected gas analyzers – except for the identification character.

11.4 Modbus function commands for the S700

11.4.1 Function codes

The S700 can process the following function codes:

Table 13:

Code	Description	Function
01	Read Coil Status	Read one or several 1-bit status information (in order to request the S700 status).
		A maximum of 64 coils can be read per command. 200 coils are available (see "Modbus read commands").
		Address: 0000H to 00C7H
03	Read Holding Register	Read one or several 16-bit data words.
		A maximum of 32 registers can be read with one command. 200 registers available of 16 bits each (see "Modbus read commands").
		Address: 0000H to 00C7H
05	Force Single Coil	Write a 1-bit information (in order to program one S700 setting).
		Each command can change 1 coil. 32 coils are available (see "Modbus control commands").
		Addresses: 0000H ... 001FH (overlapping with Read Coil Status) and 00A8H ... 00C7H (is being reset after power failure).
16	Preset Multiple Register	Write one or several 16-bit data words (in order to program S700 settings).
		Each command allows to write a maximum of 32 registers. 32 Register available (see "Modbus control commands").
		Addresses: 0000H ... 001FH (overlapping with Read Holding Register) and 00A8H ... 00C7H (is being reset after power failure).

Modbus commands with other function codes will be ignored.

11.4.2 Data formats

Data format for function values (status information)

A digital value is just 1 bit:

- Logical 0 = function OFF
- Logical 1 = function ON

A data byte consists of 8 Bits with 8 digital values:

- Bit 0 = least significant bit (lowest digital value)
- Bit 7 = most significant bit (highest digital value)

Data format for floating-point values

A floating-point value consists of two 16-bit data words (2x 16 Bit = 4 Byte):

Byte 3 (MSB)	Byte 2	Byte 1	Byte 0 (LSB)
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM

S = sign; 0 = + / 1 = –
E = exponent (2 complements biased by 127)
M = mantissa (1st mantissa)

Order of data transmission:

Byte 1	Byte 0 (LSB)	Byte 3 (MSB)	Byte 2

11.4.3 Modbus control commands

Force Single Coil

Using the control command Force Single Coil (function code 05) and its subsequent function data, the master device can control the following functions of the S700 :

data	control command
1	– not specified –
2	– not specified –
3	– not specified –
4	– not specified –
5	sample hold (20 mA measured value outputs)
6	switch-off pump
7	activate service lock
8	stop/disable automatic calibrations
9	start automatic calibration 1
10	start automatic calibration 2
11	start automatic calibration 3
12	start automatic calibration 4
13	Measured value output 1: activate range2
14	Measured value output 2: activate range 2
15	Measured value output 3: activate range 2
16	Measured value output 4: activate range 2

data	control command
17	hold sampling point 1
18	hold sampling point 2
19	hold sampling point 3
20	hold sampling point 4
21	hold sampling point 5
22	hold sampling point 6
23	hold sampling point 7
24	hold sampling point 8
25	skip sampling point 1
26	skip sampling point 2
27	skip sampling point 3
28	skip sampling point 4
29	skip sampling point 5
30	skip sampling point 6
31	skip sampling point 7
32	skip sampling point 8

Preset Multiple Register

Using the control command Preset Multiple Register (function code 16) and its subsequent register data, the master device can control the following S700 functions:

Register no.		control command	structure			
X	Y		X-high	X-low	Y-high	Y-low
R1	R2	set date in the S700	month	day	– free –	year
R3	R4	set time in the S700	hours	minutes	– free –	seconds
R5	R6	set AK-ID/Modbus mode	mode code [1]		– free –	– free –
R7	R8	– not specified –				
R9	R10	– not specified –				
R11	R12	– not specified –				
R13	R14	– not specified –				
R15	R16	– not specified –				
R17	R18	– not specified –				
R19	R20	– not specified –				
R21	R22	– not specified –				
R23	R24	– not specified –				
R25	R26	– not specified –				
R27	R28	– not specified –				
R29	R30	– not specified –				
R31	R32	– not specified –				

[1]0 = "without AK-ID" / 1 = "with AK-ID" / 2 = "with AK-ID MODBUS" (see "Activating the ID character / Activating Modbus", page 106)

11.4.4 Modbus read commands

Read Coil Status

Using the Read Coil Status command (function code 01) and its subsequent function data, the master device can read the S700 device status:

data	status
1	maintenance active
2	temp. controller 1 is heating up
3	temp. controller 1 is out of the nominal range
4	temp. controller 2 is heating up
5	temp. controller 2 is out of the nominal range
6	temp. controller 3 is heating up
7	temp. controller 3 is out of the nominal range
8	controller 4 is starting-up
9	controller 4 is out of the nominal range
10	MULTOR filter wheel: Index mark not found
11	alarm limit 1 indication is activated
12	alarm limit 2 indication is activated
13	alarm limit 3 indication is activated
14	alarm limit 4 indication is activated
15	signal for compon. 1 too high (ADC overflow)
16	signal for compon. 2 too high (ADC overflow)
17	signal for compon. 3 too high (ADC overflow)
18	signal for compon. 4 too high (ADC overflow)
19	signal for compon. 5 too high (ADC overflow)
20	A/D converter (ADC) is not ready
21	meas. value compon. 1 > 120 % of end val.[1]
22	meas. value compon. 2 > 120 % of end val.[1]
23	meas. value compon. 3 > 120 % of end val.[1]
24	meas. value compon. 4 > 120 % of end val.[1]
25	meas. value compon. 5 > 120 % of end val.[1]
26	calibration running
27	automatic calibration running
28	control output “zero gas path 1” is activated
29	control output “sample gas path” is activated
30	control output “test gas path 3” is activated
31	control output “test gas path 4” is activated
32	control output “test gas path 5” is activated
33	Measured value output 1: activate range 2 is active
34	Measured value output 2: activate range 2 is active
35	Measured value output 3: activate range 2 is active
36	Measured value output 4: activate range 2 is active
37	control output “external pump” is activated
38	zero point drift of compon. 1 > drift limit
39	zero point drift of compon. 2 > drift limit
40	zero point drift of compon. 3 > drift limit
41	zero point drift of compon. 4 > drift limit
42	zero point drift of compon. 5 > drift limit
43	sensitivity drift of compon. 1 > drift limit
44	sensitivity drift of compon. 2 > drift limit
45	sensitivity drift of compon. 3 > drift limit
46	sensitivity drift of compon. 4 > drift limit
47	sensitivity drift of compon. 5 > drift limit
48	zero pt. drift of compon. 1 > 120 % drift limit
49	zero pt. drift of compon. 2 > 120 % drift limit
50	zero pt. drift of compon. 3 > 120 % drift limit
51	zero pt. drift of compon. 4 > 120 % drift limit
52	zero pt. drift of compon. 5 > 120 % drift limit
53	sens. drift of compon. 1 > 120 % drift limit
54	sens. drift of compon. 2 > 120 % drift limit
55	sens. drift of compon. 3 > 120 % drift limit
56	sens. drift of compon. 4 > 120 % drift limit
57	sens. drift of compon. 5 > 120 % drift limit
58	pressure signal too great (ADC overflow)
59	condensate in sample gas path (int. sensor)
60	flow signal too great (ADC overflow)
61	flow < flow limit value (failure)
62	flow < flow limit value (fault)
63	control input “test gas 3 fault” is activated
64	control input “test gas 4 fault” is activated
65	control input “test gas 5 fault” is activated
66	control input “zero gas 1 fault” is activated
67	IR source malfunction
68	chopper wheel malfunction
69	failure during calibration with zero gas 1
70	failure during calibration with test gas 3
71	failure during calibration with test gas 4
72	failure during calibration with test gas 5
73	failure during calibration with cal. cuvette
74	internal power supply failure
75	control input “failure 1” is activated
76	control input “failure 2” is activated
77	control input “fault 1” is activated
78	control input “fault 2” is activated
79	control input “service 1” is activated
80	control input “service 2” is activated
81	“FAULT” status is activated
82	“SERVICE” status is activated
83	control output “zero gas path 2” is activated
84	control output “test gas path 4” is activated
85	control input “zero gas 2 fault” is activated
86	control input “test gas 6 fault” is activated
87	failure during calibration with zero gas 2
88	failure during calibration with test gas 6
89	sampling point 1 is activated
90	sampling point 2 is activated
91	sampling point 3 is activated
92	sampling point 4 is activated
93	sampling point 5 is activated
94	sampling point 6 is activated
95	sampling point 7 is activated
96	sampling point 8 is activated
97	measured values belong to sampling point 1
98	measured values belong to sampling point 2
99	measured values belong to sampling point 3
100	measured values belong to sampling point 4
101	measured values belong to sampling point 5
102	measured values belong to sampling point 6
103	measured values belong to sampling point 7
104	measured values belong to sampling point 8
105	analyzer module 1 is out of order
106	analyzer module 2 is out of order
107	analyzer module 3 is out of order
108	analog input 1 is out of order
109	analog input 2 is out of order
110	analyzer module 1 malfunction
111	analyzer module 2 malfunction
112	analyzer module 3 malfunction
113	analog input 1 malfunction
114	analog input 2 malfunction
115	calibration running with analyzer module 1
116	calibration running with analyzer module 2
117	calibration running with analyzer module 3
118	calibration running with analog input 1
119	calibration running with analog input 2
120	signal of an. module 1 is too great (ADC overfl.)
121	signal of an. module 2 is too great (ADC overfl.)
122	signal of an. module 3 is too great (ADC overfl.)
123	signal of an. module 4 is too great (ADC overfl.)
124	signal of an. module 5 is too great (ADC overfl.)

[1]of the physical measuring range

Read Coil Status

With a Read Coil Status command and its subsequent function data, the master device can check whether the S700 has received and processed the related "Force Single Coil control command:

data	control command
169	– not specified –
170	– not specified –
171	– not specified –
172	– not specified –
173	sample hold (20 mA measured value outputs)
174	switch-off pump
175	activate service lock
176	stop/disable automatic calibrations
177	start automatic calibration 1
178	start automatic calibration 2
179	start automatic calibration 3
180	start automatic calibration 4
181	Measured value output 1: activate range 2
182	Measured value output 2: activate range 2
183	Measured value output 3: activate range 2
184	Measured value output 4: activate range 2

data	control command
185	hold sampling point 1
186	hold sampling point 2
187	hold sampling point 3
188	hold sampling point 4
189	hold sampling point 5
190	hold sampling point 6
191	hold sampling point 7
192	hold sampling point 8
193	skip sampling point 1
194	skip sampling point 2
195	skip sampling point 3
196	skip sampling point 4
197	skip sampling point 5
198	skip sampling point 6
199	skip sampling point 7
200	skip sampling point 8

In the response, status "1" means "function is activated" and status "0" means "function is not activated". After power failure or switching-off the S700, the status of these messages is "not activated".

Read Holding Register

With a Read Holding Register command (function code 03) and subsequent function data, the master device can read the following values from the S700:

Register no.		status/value	structure			
X	Y		X-high	X-low	Y-high	Y-low
R1	R2	current date (in the S700)	month	day	– free –	year
R3	R4	current time (in the S700)	hours	minutes	– free –	seconds
R5	R6	measuring component 1: current measured value	floating-point value			
R7	R8	measured component 1: end value of physical measuring range.	floating-point value			
R9	R10	date of the last zero point calibration	month	day	– free –	year
R11	R12	time of the last zero point calibration	month	day	– free –	year
R13	R14	Measuring component 1: current zero point drift in %	floating-point value			
R15	R16	date of the last sensitivity calibration	month	day	– free –	year
R17	R18	time of the last sensitivity calibration	month	day	– free –	year
R19	R20	measuring component 1: current sensitivity drift in %	floating-point value			
R21	R22	measuring component 1: previous zero point drift in %	floating-point value			
R23	R24	measuring component 1: previous sensitivity drift in %	floating-point value			
R25	R26	– not specified –				
R27	R28	– not specified –				
R29	R30	– not specified –				
R31	R32	current date (in the S700)	month	day	– free –	year
R33	R34	current time (in the S700)	hours	minutes	– free –	seconds
R35	R36	measuring component 2: current meas. value	floating-point value			
R37	R38	measuring component 2: end value of physical range.	floating-point value			
R39	R40	date of the last zero point calibration	month	day	– free –	year
R41	R42	time of the last zero point calibration	month	day	– free –	year
R43	R44	meas. comp. 2: current zero point drift in %	floating-point value			
R45	R46	date of the last sensitivity calibration	month	day	– free –	year
R47	R48	time of the last sensitivity calibration	month	day	– free –	year
R49	R50	meas. comp. 2: current sensitivity drift in %	floating-point value			
R51	R52	meas. comp. 2: previous zero point drift in %	floating-point value			
R53	R54	meas. comp. 2: previous sensitivity drift in %	floating-point value			
R55	R56	– not specified –				
R57	R58	– not specified –				
R59	R60	– not specified –				
R61	R62	current date (in the S700)	month	day	– free –	year
R63	R64	current time (in the S700)	hours	minutes	– free –	seconds
R65	R66	measuring component 3: current meas. value	floating-point value			
R67	R68	meas. comp. 3: end value of physical range	floating-point value			
R69	R70	date of the last zero point calibration	month	day	– free –	year
R71	R72	time of the last zero point calibration	month	day	– free –	year
R73	R74	meas. comp. 3: current zero point drift in %	floating-point value			

R75	R76	date of the last sensitivity calibration	month	day	– free –	year
R77	R78	time of the last sensitivity calibration	month	day	– free –	year
R79	R80	meas. comp. 3: current sensitivity drift in %	floating-point value			
R81	R82	meas. comp. 3: previous zero point drift in %	floating-point value			
R83	R84	meas. comp. 3: previous sensitivity drift in %	floating-point value			
R85	R86	– not specified –				
R87	R48	– not specified –				
R89	R90	– not specified –				
R91	R92	current date (in the S700)	month	day	– free –	year
R93	R94	current time (in the S700)	hours	minutes	– free –	seconds
R95	R96	meas. comp. 4: current meas. value	floating-point value			
R97	R98	meas. comp. 4: end value of physical range.	floating-point value			
R99	R100	date of the last zero point calibration	month	day	– free –	year
R101	R102	time of the last zero point calibration	month	day	– free –	year
R103	R104	meas. comp. 4: current zero point drift in %	floating-point value			
R105	R106	date of the last sensitivity calibration	month	day	– free –	year
R107	R108	time of the last sensitivity calibration	month	day	– free –	year
R109	R110	meas. comp. 4: current sensitivity drift in %	floating-point value			
R111	R112	meas. comp. 4: previous zero point drift in %	floating-point value			
R113	R114	meas. comp. 4: previous sensitivity drift in %	floating-point value			
R115	R116	– not specified –				
R117	R118	– not specified –				
R119	R120	– not specified –				
R121	R122	current date (in the S700)	month	day	– free –	year
R123	R124	current time (in the S700)	hours	minutes	– free –	seconds
R125	R126	measuring component 5: current meas. value	floating-point value			
R127	R128	meas. comp. 5: end value of physical range.	floating-point value			
R129	R130	date of the last zero point calibration	month	day	– free –	year
R131	R132	time of the last zero point calibration	month	day	– free –	year
R133	R134	meas. comp. 5: current zero point drift in %	floating-point value			
R135	R136	date of the last sensitivity calibration	month	day	– free –	year
R137	R138	time of the last sensitivity calibration	month	day	– free –	year
R139	R140	meas. comp. 5: current sensitivity drift in %	floating-point value			
R141	R142	meas. comp. 5: previous zero point drift in %	floating-point value			
R143	R144	meas. comp. 5: previous sensitivity drift in %	floating-point value			
R145	R146	– not specified –				
R147	R148	– not specified –				
R149	R150	– not specified –				
R151	R152	pressure [hPa] (meas. value of int. sensor)	floating-point value			
R153	R154	flow [l/h] (measured value of internal sensor)	floating-point value			
R155	R156	temperature [°C] for int. temp. compensation	floating-point value			
R157	R158	IR source supply voltage [V]	floating-point value			
R159	R160	signal input 1 [V]	floating-point value			
R161	R162	signal input 2 [V]	floating-point value			
R163	R164	– not specified –				
R165	R166	– not specified –				
R167	R168	– not specified –				
R169	R170	"set current date" command received	month	day	– free –	year
R171	R172	"set current time" command received	hours	minutes	– free –	seconds
R173	R174	"set AK-ID/Modbus mode" command received	mode code [1]		– free –	– free –
R175	R176	– not specified –				
R175	R176	– not specified –				
to						
R199	R200					

[1]0 = "without AK-ID" / 1 = "with AK-ID" / 2 = "with AK-ID MODBUS" (see "Activating the ID character / Activating Modbus", page 106)

12 Maintenance

12.1 Safety information on disassembly of components

12.1.1 Decontamination

WARNING: Risk to health through contact with dangerous gases
Residues of noxious gases can be released when opening components with sample gas contact.

Before opening components with sample gas contact:

- *Remove gaseous residues:* Purge all parts with sample gas contact with dry N_2 for two hours.
- *Remove solid/liquid residues:* Carry out decontamination appropriate for the requirements arising from this contamination (if required, contact SICK Service).

Before starting maintenance / repair work on the enclosure:
If the enclosure also has contact with toxic gases during the application, decontaminate the enclosure as well before carrying out maintenance/repairs.

- Decontaminate the enclosure appropriately for the requirements resulting from this type of contamination. Observe all relevant cleaning information.

12.1.2 Possible risks through gas from internal components

WARNING: Health risk through dangerous gases in the enclosure
A small amount of dangerous gas may be enclosed in the analyzer modules. When the component becomes leaky, this gas escapes into the enclosure (possible gases and amounts, (see Table 14).
To prevent danger through such a gas:

- *Before opening the enclosure (especially when an internal defect is suspected):* Ensure breathing protection (e.g. adequate ventilation/suctioning off).
- Also check the state of the internal components during regular maintenance measures (see “Maintenance plan”, page 174). Repair components which seem to be damaged or are questionable.

Analyzer module	Possibly enclosed gas	Maximum gas amount	Maximum gas concentration in the enclosure in case of a defect
DEFOR UNOR MULTOR SIDOR	CO · NO · NO_2 · SO_2 · NH_3 · N_2O · hydrocarbons · freon	50 ml	1000 ppm

Table 14: Dangerous gases in analyzer modules

12.2 Maintenance plan

Table 15: Maintenance plan

Maintenance period	Maintenance work	
1 ... 2 days	▶ Make a visual inspection.	see “Visual check”, page 175
1 week ... 1 month	▶ Run calibrations (except for H_2O).	see “Manual calibration”, page 130 see “Automatic calibration”, page 133
	▶ Check sensitivity drift of OXOR-E module. [1]	see “Setting the drift limit values”, page 137
	▶ Check important signal connections.	see “Testing the electrical signals”, page 175
	▶ Check the flow monitor. [2]	[3]
approx. 6 months	▶ Check the gas lines for leaks.	see “Leak tightness check of sample gas path”, page 176
	▶ Check/change the internal safety filter.	[4]
	▶ Check the built-in gas pump. [2]	[4]
approx. 1 year	▶ Perform a H_2O calibration. [2]	see “Calibration of the H2O measurement”, page 151
1 ... 2 years	▶ Perform a full calibration. [5]	see “Full calibration”, page 144
1 ... 5 years	▶ Replace the OXOR-E module. [2]	see “Replacing the O2 sensor in the OXOR-E module”, page 180

[1] only for analyzers which are equipped with the analyzer module OXOR-E
[2] only for analyzers which are equipped with this feature
[3] reduce sample gas flow to the S700 and check for fault indication (see “Setting the flow monitor set point”, page 114).
[4] should be performed by a service technician or a trained skilled person
[5] only for analyzers working with internal cross-sensitivity compensation

In addition, please observe all official and internal company regulations which are valid for your application.

12.3 Visual check

Function

A visual inspection is made to check the operating state of the analyzer.

Maintenance period

Recommendation: Max. 2 days

Procedure

- *S700:*
  - LED Function: Should continuously light *green*.
    When Function lights red: Observe status messages on the display (information, see “Status messages (in alphabetical order)”, page 186).
  - LED Service: Should *not* light.
    When Service lights: Observe status messages on the display (information, see “Status messages (in alphabetical order)”, page 186).
- *Peripherals:*
  - Check all system devices (for example: gas filter, sample gas cooler, converter).
  - Check the gas lines (state, connections).
  - When calibration gases are fed automatically: Check state and availability of the calibration gases (e.g. delivery pressure from the central gas supply, remaining quantity in the gas cylinders, expiration date).
  - *In potentially explosive atmospheres:* Check the state of the connection cables.

WARNING: Risk of explosion through damaged connection cables
In potentially explosive atmospheres: All connection cables have to be intact and correctly installed.
▶ Also check the state of the connection cables during a visual check.
When a cable is damaged:
▶ Take the S700 out of operation (and/or do not start-up).
▶ Replace the damaged cable.

12.4 Testing the electrical signals

Function

If you are using the S700 to give an alarm in case of a dangerous operating state or to control important processes, then you should regularly check that all electrical functions and connections are working correctly.

Maintenance period

Recommendation: Max. 1 month

Procedure

1. Check if the external processing of the S700 signals should be deactivated before a test can be done (for example: measured value signals, control signals). If so, carry out the necessary measures.
2. Inform the connected stations that you intend to make a test.
3. Use the `hardware test` functions to test all important S700 electrical signals (see “Testing electronic outputs (hardware test)”, page 121).

12.5 Leak tightness check of sample gas path

12.5.1 Safety notes on leak tightness

WARNING: Hazards caused by leaky gas lines

- If the sample gas is poisonous or harmful, a danger to health exists if the gas path is leaky.
- If the sample gas is corrosive or can create corrosive liquids with water (for example, with air humidity), then escaping sample gas might cause damage to the gas analyzer and proximate devices.
- If the escaped gas can create an explosive gas mixture with the ambient air, risk of explosion occurs if the safety precautions against explosion hazards have not been maintained.
- If the gas path is leaky, then the measured values are possibly wrong.

If the gas path is noticed to be leaky:

- ▶ Stop the gas feed.
- ▶ Take the gas analyzer out of operation.
- ▶ *If the escaping gas can be dangerous to health, corrosive or combustible:* Remove the escaping gas systematically (purge, suction off, vent) whilst maintaining the necessary safety measures, e.g. for
  - explosion prevention (for example, purge the enclosure with neutral gas)
  - health protection (for example, wear respiratory equipment)
  - pollution control

Leak tightness check of the S715 enclosure, see “Leak tightness check for the enclosure S715 EX”, page 178.

12.5.2 Test criteria for gas-tightness

- For the stated test gas pressure ((see Table 16), the leak rate of the internal gas path of the gas analyzer may not be higher than $3.75 \cdot 10^{-3}$ mbar · l/s. Otherwise, the gas analyzer must be considered leaky.
- Recommended test interval: Max. 6 months.

Version of the internal gas path	Test pressure
hosed	450 mbar
hosed– without analyzer module “OXOR-E”	1,5 bar
hosed– with analyzer module “OXOR-E”	450 mbar

Table 16: Test gas pressure for the leak tightness check of the sample gas path

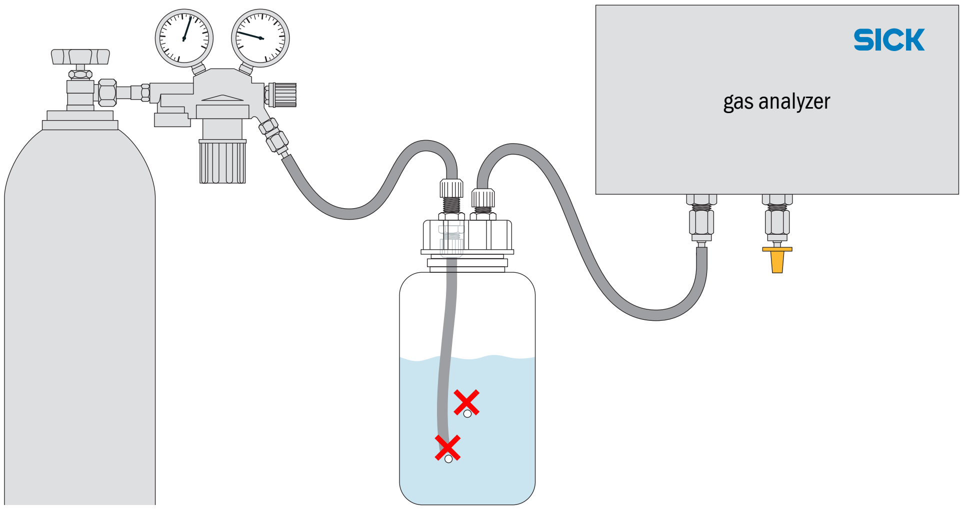
12.5.3 A simple leak test method

Test equipment

For a simple test, you will need

- a compressed gas cylinder with adjustable pressure reducer (recommendation: Nitrogen)
- a “washing flask” or similar with two hose connectors (see Fig. 23, page 177).
  - The washing flask must withstand the test pressure and must close gas-tight.
  - The outlet diameter of the hose (or tube) which extends into the water should be 4 mm (0.2 inch).
  - Ordinary water can be used for the filling. Set-up a filling level where no water can escape through the gas connections.

Fig. 23: A simple leak test method (example)



Test procedure

> *If the gas analyzer is equipped with several separate internal gas paths:*
> ▶ Make this procedure once for each individual gas path.

1 Take the gas analyzer out of operation. Disconnect the gas inlet and outlet of the analyzer from the connected installations (if existing).
2 Connect the gas inlet of the analyzer to the gas outlet of the washing flask.
3 Seal the gas outlet of the analyzer gas-tight, for example with a suitable plug.
4 Seal all the other gas connections of the internal gas path (if existing) in the same way.
5 Check: The valve on the pressure reducer gas outlet must be closed off. Then open the main valve of the gas cylinder.
6 Adjust the pressure reducer so that the output pressure (secondary pressure) corresponds to the test pressure (see Table 16, page 176).
7 Connect the gas outlet of the pressure reducer to the gas inlet of the washing flask.
8 *Slowly* open the outlet valve of the pressure reducer (avoid pressure shock).
9 Wait until the pressure in the test system is constant (may take some seconds).
10 Observe the washing flask for 3 minutes.
If no air bubbles rise during this time, the gas path is considered tight.
11 To finish with the test:
- Shut the outlet valve of the pressure reducer.
- To release the gas pressure: Carefully loosen the connection hose *on the washing flask gas outlet*.
- Refit all the regular gas connections of the analyzer – with high attention to gas-tightness.

12.6 Leak tightness check for the enclosure S715 EX

Also applies for S715 EX CSA.

WARNING: Risk of explosion through leaky enclosure
When the enclosure of the S715 EX had been opened, check whether the enclosure is "vapor-proof" before start-up.
- ▶ Check the state of the enclosure seals before closing the enclosure.
- ▶ After closing the enclosure, perform a leak tightness check.
- ▶ Do not start up the S715 EX when the enclosure has not passed the leak tightness check.

WARNING: Risk of explosion through defective enclosure seals
The explosion protection of the enclosure is only ensured when all enclosure seals are correctly installed and intact.
- ▶ *Before closing the enclosure:* Check the state of the enclosure seals.
- ▶ Have the damaged seals replaced by the manufacturer's Customer Service.

Check of internal leak tightness, see "Leak tightness check of sample gas path", page 176.

1 Prepare a gas connection:

Table 17:

For analyzers *without* purge gas connections	For analyzers *with* purge gas connections
1 Loosen the fitting on the left side of the enclosure and remove the closing plug (see Fig. 24, page 179). 2 Fit the hose fitting (in scope of delivery) instead of the closing plug. Fasten the screw fitting gas-tight.	1 Block or seal one of the purge gas connections, for example by closing an valve in the external purge gas line. 2 Prepare the other purge gas connection in order to allow the introduction of gas, however in such a way that the connection can be closed. (If no special equipment has been installed for this purpose, disconnect the external purge gas line from the connector and install a hose connector instead.)

2 Connect a pressure gauge to the hose connection (measuring range should cover 0 ... 300 Pa) as well as a device which can be used to create a partial vacuum of 300 Pa (3 mbar) against the ambient pressure (e.g. a pump) in the S715 EX.

3 Create a partial vacuum of 300 Pa (3 mbar) in the S715 EX. Then stop the gas feed and close off, and read the manometer.

Damage of the enclosure
A higher pressure difference can damage the enclosure.
- ▶ Do not apply a higher pressure than specified.

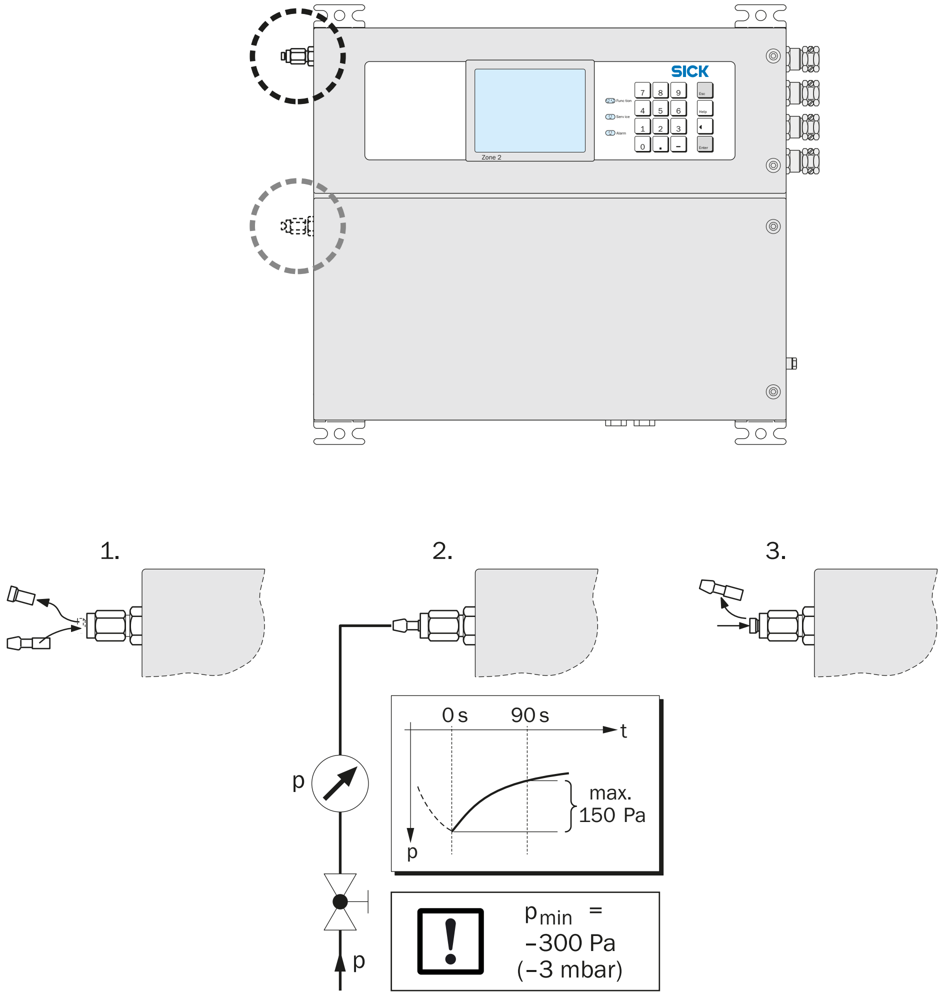
Although the pressure difference is small, it may take some minutes to establish the required pressure difference.

4 After 90 seconds, read the manometer again:

Table 18:

If the pressure has dropped no more than 150 Pa:	If the pressure has dropped more than 150 Pa:
Test is passed. 1 Remove the test installations. 2 Wait until the pressure has fully escaped the enclosure. 3 Reinstall the closing plug again gas-tight. The S715 EX can now be put into operation.	Test has failed. 1 Check the sealing of the enclosure (sealings, cable inlets, closing caps). 2 Then perform the test again.

Fig. 24: Leak tightness check in zone 2 for S715 EX



12.7 Replacing the O_2 sensor in the OXOR-E module

Only applies for the S700 with the analyzer module OXOR-E (see "Analyzer modules for O2 measurement", page 25).

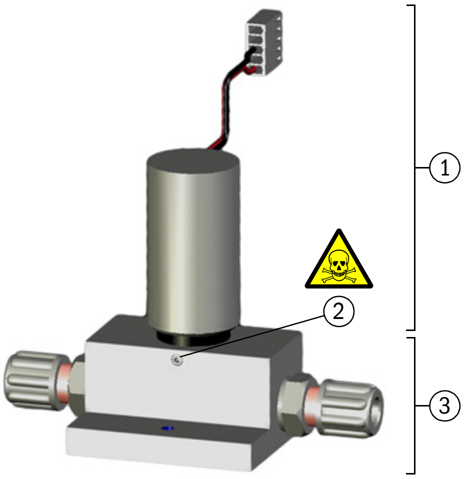
Maintenance period

The analyzer module OXOR-E consists of an electrochemical O_2 sensor and a base with hose connections. Due to the measuring principle, the expected life of the O_2 sensor is limited. The following criteria indicate when the service life has ended:

- The response time of the O_2 measurement is permanently increasing.
- The O_2 sensitivity is rapidly decreasing, which means that the O_2 sensitivity drift is rapidly increasing (see "Display of drift values", page 80).

- *Recommendation:* As a preventive measure, renew the O_2 sensor after about two years operating time.
- You can automatically monitor the O_2 sensitivity drift by setting a suitable drift limit value for the O_2 measurement (see "Setting the drift limit values", page 137).

Fig. 25: Analyzer module OXOR-E



1 O_2 sensor
2 Clamping screw
3 Base

Procedure

WARNING: Risk for your health
If the sample gas contains poisonous or dangerous components:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before opening any gas paths or parts with sample gas contact.

1. Stop the sample gas flow to the S700 (close valve / switch off the pump) and take the S700 out of operation.
2. Open the S700:
   - S710/S711: Remove the enclosure cover on the top.
   - S715: Open the lower part of the enclosure.
   - S720 Ex/S721 Ex: Open the analyzer enclosure (procedure and safety information, see "Opening and closing the enclosure", page 44).
3. Inside, disconnect the connection cable of the O_2 sensor (plug connection).
4. Loosen the clamping screw of the O_2 sensor.
5. Pull the O_2 sensor out of the base.

6 Check the sealing ring and the sealing surfaces.

CAUTION: Risks by incorrect assembly
The connection between O_2 sensor and base has to be gas-tight:
- Make sure that the O-ring (sealing ring) is intact.
- Make sure that the sealing surfaces are clean and dust-free.

Otherwise sample gas could escape during operation and the measurements could be erroneous.

To simplify fitting: Apply a thin film of high vacuum grease (high quality glass grease) to the sealing ring. Do not use any other liquid or material.

7 Insert the new O_2 sensor into the base (to the mechanical stop).
8 Fix the module with the clamping screw.
9 Connect the connection cable of the O_2 sensor to the electronic board (→ X20).
10 Close the enclosure and restart the S700. Wait for an appropriate warm-up time. Then restart the sample gas flow.
11 Run a basic calibration for O_2 (see page 145).

Disposal

The O_2 sensor contains acid. Dispose of the spent O_2 sensors in the same manner as batteries.

Spare parts

Part No.	Description	Remarks
2071139	ET-OXOR-E Consumable parts set for retrofit set	= O_2 sensor (without base)
2071115	OXOR-E, hosed (retrofit set)	= complete OXOR-E module (O_2 sensor + base

NOTE:
Long storage periods shorten the service life of the O_2 sensor.
- Store the O_2 sensor as cool as possible.
- Maintain the allowable storage temperature: –20 ... +60 °C (–4 ... 140 °F).

12.8 Cleaning the enclosure

- To clean the enclosure, use a soft cloth.
- If required, wet the cloth with water and a mild cleaning solution.
- Do not use any mechanically or chemically aggressive cleaning agents.
- Do not allow any liquids into the enclosure.

CAUTION: Hazardous situation if liquids enter the enclosure

If liquids have entered the device:

- Do not touch the device any more.
- Take the device out of operation by disconnecting the power at an *external* point (for example, pull out the power plug at the socket or switch off the external mains fuse).
- Contact the manufacturer's Customer Service or a trained skilled person able to repair the device.

13 Clearing malfunctions

13.1 If the S700 does not work at all ...

CAUTION: Health risks
▶ *Before any measures are taken inside the S700:* Observe the general safety notes (see “General safety information on installation”, page 34).

Possible causes	Notes
Power cable is not connected.	▶ Check the power cable and its connections.
Main switch is off.	▶ Check the (external) mains power switch. ▶ Check the main power switch on the S700. – *S710/S711:* on the rear – *S715:* in the lower enclosure section – *S720 Ex/S721 Ex:* in the analyzer enclosure
Power supply is shut off.	▶ Check the power supply (for example: power socket, external fuses).
Internal power fuse is defective.	▶ Check the internal power fuses (see “Adapting to power voltage”, page 184).
Internal operating temperatures are not correct.	▶ Check whether relevant malfunction messages are displayed (“`FAULT: Temperature`…”; Display, see “Display of status/malfunction messages”, page 77; Information, see “Status messages (in alphabetical order)”, page 186).
The sample gas delivery is not working correctly.	see “Sample gas connections”, page 37
The internal software is not working correctly.	Can only happen after a complex internal failure or by strong external interferences (for example, strong electromagnetic impulses). ▶ Switch off the S700. Wait for a few seconds, then switch on again.
An internal overheat protection has triggered.	Heated analyzer modules and the internal power transformer (starting from 2001) are equipped with overheat circuit breakers. These breakers are irreversible: After being blown, the circuit breaker is defective and needs to be replaced. ▶ Call the manufacturer’s Customer Service in order to replace the defective overheat circuit breaker.

▶ *If the S700 does however not start-up after you have followed these notes:* Contact the manufacturer’s Customer Service.

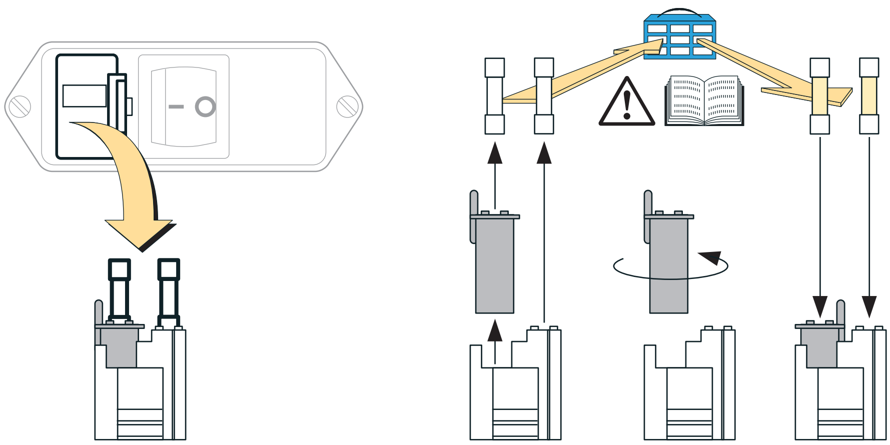
13.2 Fuses

13.2.1 Adapting to power voltage

The S700 can be set to 100 V, 115 V or 230 V mains voltage. To change the setting:

1. Disconnect the S700 from the power supply.
2. Pull out the fuse box (see Fig. 26, page 184).
3. Remove the existing fuses.
4. One of the fuse holders can be removed from the fuse box. Pull out this fuse holder, turn it 90° or 180° (as required) and put it back into the fuse box. The desired line voltage window should now be indicated on the front of the fuse box.
5. Insert fuses with matching specification (see “Internal fuses”, page 185) into the fuse holders.
6. Refit the fuse box.

Fig. 26: Power fuses / Changing the required mains voltage



13.2.2 Internal fuses

CAUTION: Health risk

As long as the fuse box is removed, there are free electrical contacts which output the mains power voltage.

- *Before testing the fuses:* Disconnect the S700 from the power supply or switch the power supply off at an external point.

CAUTION: Risk of fire or damage by wrong fuses

If wrong fuses are installed, a fire could possibly be started when an internal component becomes defective.

- Use only those fuses as replacement which exactly meet the specified values (type of design, switch-off current, switch-off features).
- Only use fuses approved by CSA.

Table 19: Mains fuses

Line voltage	Fuse(s)	Part No.
100 V	T 4A0 250V D5x20	6004310
115 V		
230 V	T 2A0 250V D5x20	6057142

Table 20: Fuses on the internal electronics board – revision 4 (latest version)

Identification	Fuse(s)	Part No.	Protects
F1	TR5-F F1A0	6021782	+24 VDC output (see “Outputs for signal voltage (auxiliary voltage)”, page 55)
F2	TR5-F F4A0	6010712	+24 VDC for relays, internal heating, internal gas pump (option)
F3	TR5-F F1A6	6026950	+5 VDC for digital electronics, IR source (UNOR, MULTOR)
F4	TR5-F F0A8	6032017	+15 VDC for analog electronics, measured value output, motors
F5			−15 VDC for analog electronics, measured value output, motors

Table 21: Fuses on the internal electronics board – revision 1/2/3 (earlier versions)

Identification	Fuse(s)	Part No.	Protects
F1	TR5-F F1A0	6021782	+24 VDC output (see “Outputs for signal voltage (auxiliary voltage)”, page 55)
F2	TR5-F F4A0	6010712	+24 VDC for relays, internal heating, internal gas pump (option)
F3	TR5-F F2A0	6028000	+5 VDC for digital electronics, IR source (UNOR, MULTOR)
F4	TR5-F F0A63 [1]	6028839	−15 VDC for analog electronics, measured value output, motors
F5			+15 VDC for analog electronics, measured value output, motors

[1] In earlier versions, F4 and F5 are equipped with F0A5 fuses. These may be replaced by F0A63 fuses.

- There are further electronic fuses with the option “intrinsically safe measured value outputs” (see “Intrinsically-safe measured value outputs”, page 63).
- Each analyzer module has its own overheat fuse (see “FAULT: temperature x”, page 188).

13.3 Status messages (in alphabetical order)

CAUTION: Health risks / damage risks
"Notes for service" are given for trained service technicians only.
▶ Do not do any work inside the S700 if you are not familiar with the possible hazards.

WARNING: Risk for your health
If the S700 has been used to measure poisonous or dangerous gases:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before disassembling any gas path components.

Display message	Meaning	Cause/Notes for operator	Notes for service
`Calibration active`	A calibration procedure is running.	No malfunction message.	
`CALIBRATION ext. x` (x = 1 ... 2)	A calibration is running with the measuring component which represents the measuring signal from analog input INx (see "Analog inputs", page 58).		
`CALIBRATION sensor x` (x = 1 ... 3)	Calibration is running with analyzer module x.	Coding of x see "Display of device data", page 79	
`CHECK STATUS/ FAULTS`	Several status and/or malfunction message exist at the present time.	▸ Call up list of status/malfunction messages (see "Display of status/malfunction messages", page 77)	
`FAILURE extern x` (x = 1 ... 2)	Control input "Failure x" is activated.	Indicates a failure signal from an external device (see "Available control functions", page 99). Not a trouble in the S700 .	If control logic is reversed, this message will also occur when the electrical connection is interrupted. *Information:* This message is not related in any way to the status output "FAILURE extern x" (see "Available switching functions", page 98).
`FAILURE sensor x` (x = 1 ... 3)	Analyzer module x is not fully operational. (Coding of x, see "Display of device data", page 79).	Possible causes: – The internal temperature is not in the nominal range of the heating control. – The zero point drift or sensitivity drift exceeds 120 % of the drift limit value set (see page 137). – The measuring signal of the analyzer module is not in the operational range. – UNOR/MULTOR: The analyzer module is defective.	Possible defect for UNOR/MULTOR: The chopper disk (chopper) does not rotate correctly.
`FAILURE Sensor ext.x` (x = 1 ... 2)	The measured value which represents the internally processed measuring signal from analog input INx (see "Analog inputs", page 58) is probably wrong.	The zero drift or sensitivity drift of the measuring signal is greater than 120 % of the drift limit value set (see page 137).	
`FAULT: Cal. cuvette`	After a calibration with calibration cuvette, the sensitivity drift is significantly higher than the drift limit value set (over 120 % of the drift limit value).	Possible causes: – No zero gas was fed while the calibration cuvette was active (e.g. gas feed did not work correctly). – The nominal values of the calibration cuvette are no longer correct (see "Calibration of the calibration cuvette (option)", page 150). – The calibration cuvette did not work correctly (see service information).	Possible defects: – Drive mechanism defective – Motor defective – Electrical connection defective – Gas filling of the calibration cuvette defective
`FAULT: chopper`	Rotation signal from the chopper in the UNOR or MULTOR module is missing.	The S700 is defective. ▸ Contact the manufacturer's Customer Service.	▸ Electrical connection? ▸ Chopper loose or stuck? ▸ Defective motor? ▸ Defective photoelectric barrier? ▸ Defective chopper motor control?
`FAULT: compensation`	The temperature sensor which is used for the temperature compensation of the modules does not work.	*Electronic board as from revision 5:* Jumper on position X25 is missing.	▸ Set a jumper so that the middle and right pins of X25 are bridged (seen from the front). The pins are not labeled.
		The temperature sensor is defective.	The temperature sensor is part of the electronic board (can not be replaced individually). ▸ Replace the complete electronic board.

Display message	Meaning	Cause/Notes for operator	Notes for service
`FAULT: condensate`	Condensate is present in the internal sample gas path of the S700. – This message triggers automatic deactivation of the gas pump and the switching output “external pump” (if setup).	The S700 must be serviced. ▸ Put the S700 out of operation. ▸ Contact the manufacturer’s Customer Service or a trained skilled person. *After servicing:* ▸ Switch malfunction message off per menu (see “Acknowledging alarms”, page 82).	1. Check/service external sample gas conditioning. 2. Service S700: ▸ Separate analyzer modules from internal sample gas path to prevent condensate penetrating. ▸ Corrosive condensate, electrically conductive residues → remove condensate sensor, rinse with demineralized water and dry. ▸ Purge the condensate sensor and the internal sample gas paths (incl. pump) with dry air. ▸ Check internal safety filter (glass); replace if necessary. ▸ *When condensate could have entered the analyzer module:* Service/replace the module.
`FAULT: controller 4`	(The actual value of controller 4 is outside the nominal range.)	–	Reserved for future use.
`FAULT: filter wheel`	Rotation signal from filter wheel of the MULTOR module is missing.	▸ Switch the S700 off and on again. ▸ *If this does not help:* Inform the manufacturer's Customer Service – the S700 is defective.	– Electrical connection? – Filter wheel loose or stuck? – Defective photoelectric barrier? – Step motor defective? – Control of the step motor defective?
`FAULT: flow signal`	The signal from the flow sensor has exceeded the operating range of the internal analog/ digital converter.	▸ *If the message remains displayed for a longer time (several seconds):* Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ Try disconnecting the sensor cable from the electronics board. ▸ *If the malfunction message has disappeared:* Check cable and sensor.
`FAULT: gas flow`	The gas flow in the sample gas path of the S700 is lower than 50 % of the programmed limit value (see “Setting the flow monitor set point”, page 114).	▸ *During measuring operation:* Check sample gas feed (filter, valves, lines, etc.) ▸ *During a calibration:* Check calibration gas feed (gas cylinders, setting of the pressure reducer, valves, etc.).	Only appears for devices with option “flow monitor”. In the range from 50 ... 100 % of the limit value `SERVICE: gas flow` appears instead.
`FAULT: int. voltage`	At least one internal supply voltage is not OK (outside the nominal range).	▸ Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ Check the internal supply voltage (see “Internal supply voltages”, page 117) and internal fuses (see “Internal fuses”, page 185). ▸ *If no fault detectable:* Replace electronic board as test.
`FAULT: IR source`	Infrared heater of the analyzer module UNOR or MULTOR is defective or interrupted.	The S700 is out of order. ▸ Contact manufacturer’s Customer Service or trained skilled persons.	▸ Check heater voltage (see “Signals of the internal sensors and analog inputs”, page 116): – Too high? Cable defective? Heater severely damaged or unusable? – Too low? Short circuit? Electronics defective? Heater defective? Fuse defective (see “Internal fuses”, page 185)? (Setting of the nominal voltage is part of the “factory setting”; perform a basic calibration after changes.)
`FAULT: overrange x` (x = `1` ... `5`)	Measured value of measuring component x is higher than 120% of the physical measuring range end value. *Attention:* The displayed measured value does probably not represent the real concentration of the measuring components.	▸ Check whether the concentration of the measuring component could actually be this high now. ▸ *If this is the case:* Contact the manufacturer's Customer Service or trained skilled persons.	Clearance not possible by changing settings. ▸ *When measured value should be within measuring range:* Loosen electrical connection of the affected analyzer module. ▸ *When the error message has disappeared:* Service/replace the module.
`FAULT: pressure signal`	Signal from the pressure sensor exceeds the working range of the internal analog-to-digital converter.	▸ *If the message remains displayed for a longer time (several seconds):* Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ Separate pressure sensor from electronic board as test (plug connector X21). Put the S700 back into operation. ▸ *If the malfunction message has disappeared:* Replace sensor.

Display message	Meaning	Cause/Notes for operator	Notes for service
FAULT: S-drift #x (x = 1 ... 5)	The sensitivity drift is significantly greater than the set drift limit value for measuring component x (over 120 % of the limit value).	Possible causes: – Test gas was not available (check gas cylinders). – Gas delivery does not work correctly (check gas lines, valve function, gas flow). – The set nominal value does not match the real test gas concentration (see "Test gases for sensitivity calibration", page 127). – Message SERVICE: S-drift was ignored even though the deviation from basic state is very large. – For O2 see the special notes (see "Replacing the O2 sensor in the OXOR-E module", page 180). ▸ Eliminate the cause. ▸ Then run a calibration.	▸ Check the settings for test gas delay time and calibration measuring interval (see page 138 and Page 139). ▸ Check the drift limit value settings (see "Setting the drift limit values", page 137). ▸ *If this fault appears often during operation for UNOR or MULTOR components:* increase the respective drift limit values (especially applies to low measuring ranges). ▸ Thoroughly check test gases and gas lines. ▸ After above, run a calibration and check the drift values (see "Display of drift values", page 80). *If drift values are still too high:* ▸ Clean/adjust the analyzer module. ▸ Then perform a basic calibration.
FAULT: Signal #x (x = 1 ... 5)	Measurring signal for measuring component x cannot be processed internally.	▸ Switch the S700 off and on again. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	▸ (Signal has exceeded the value range of the internal analog-to-digital transducer.) Try disconnecting the electrical connection to the analyzer module.
FAULT: temperature x (x = 1 ... 3)	Temperature of analyzer module x is not within the operating range.	Possible causes: ▸ Ambient temperature is either too high or too low ▸ The internal heating is not working ▸ The S700 was previously switched off for a short time When this message appears after a short operating break of the S700, the error message will disappear after a few minutes. In all other cases: ▸ Check ambient temperature. Note: When the S700 is fitted in an outer housing (or for example a cabinet), check the temperature in the outer housing, not the outdoor temperature. ▸ If necessary, take suitable measures to correct the ambient temperature. ▸ *If this does not help:* Inform manufacturer's Customer Service or trained skilled persons.	Possible defects: – Electrical fuse (see "Internal fuses", page 185) – Temperature sensor in the analyzer module – Electrical connections in heating circuit – Heating electronics defective – Overheat fuse in the analyzer module (breaks at approx. 80 °C). Chemical fusible cutout; must be replaced after triggering.
FAULT: test gas x (x = 3 ... 6)	Control input "Test gas x fault" was activated during calibration.	Only applicable when such a control input is installed (see "Available control functions", page 99). ▸ Check whether a corresponding external malfunction exists (e.g. gas cylinder is empty). ▸ *When malfunction cleared:* Repeat calibration.	Further possible causes: – Electrical connection defective – External monitoring device defective
	At least one measured actual value deviated strongly from the nominal value (calculated drift exceeded 200% of set drift limit value) when feeding the specified calibration gas during the last automatic calibration.	Possible causes: – The calibration gas was not available (check pressure cylinder). – Gas feed did not work correctly (check gas lines, valve functions and gas flow). – Set nominal value does not match gas used (see "Setting the nominal values for the calibration gases", page 136). – Set nominal value does not meet the physical requirements (see "Zero gases (calibration gases for the zero point)", page 126). ▸ Check the drifts to find out which measuring component causes the problem (see "Display of drift values", page 80). ▸ Eliminate the cause. ▸ Then run a calibration again (automatic or manual).	▸ Check calibration gases. ▸ Check gas lines. ▸ Check the settings for test gas delay time and calibration measuring interval (see page 138 and Page 139). ▸ Check the drift limit value settings (see "Setting the drift limit values", page 137). ▸ Possibly perform a manual calibration procedure to observe the process exactly.

Display message	Meaning	Cause/Notes for operator	Notes for service
FAULT: Z-Drift #x (x = 1 ... 5)	Zero drift for measuring component x is considerably above the set drift limit value (over 120% of the drift limit value).	→ Fault S-Drift X	→ Fault S-Drift X
FAULT: zero gas x (x = 1 ... 2)	→ Fault Test gas x	→ Fault Test gas X	→ Fault Test gas X
Heating ... x (x = 1 ... 3)	The S700 has not yet reached its operating temperature after power-on (x = internal heating circuit).	Not a fault. These messages will disappear within 30 minutes after power-on. ▸ Do not perform any binding measurements or any calibrations as long as these kind of messages are displayed.	This message does not disappear when the S700 does not reach the relevant nominal temperature. Possible causes: Ambient temperature too low, internal heating defective.
INTERRUPT ext. x (x = 1 ... 2)	Control input "fault x" is activated.	Indicates a fault signal from an external device (see "Available control functions", page 99). Not a trouble in the S700.	If control logic is reversed, this message will also occur when the electrical connection is interrupted.
maintenance/ calibration	Status output "service" activated manually.	see "Activating the maintenance signal", page 84	
	A calibration procedure is running.	Remains after the test gas feed has finished until a test gas delay time has elapsed.	
	A function of menu branch 7 (Service) has been called.	Some of these menus will interrupt the S700 measuring function. Therefore usage of these menu branches automatically activates the maintenance signal.	
No reports!	There are no status or malfunction messages at this time.	Only appears in the list of status/malfunction messages (see "Display of status/malfunction messages", page 77).	
PC control active !	External PC controls the S700	See also "Remote control with "AK protocol"", page 159.	
SERVICE extern x (x = 1 ... 2)	Control input "Service x" is activated.	Indicates a failure signal from an external device (see "Available control functions", page 99). Not a trouble in the S700 .	If control logic is reversed, this message will also occur when the electrical connection is interrupted.
SERVICE: gas flow	The volume flow in the sample gas path of the S700 is somewhat lower than the set limit value of the flow monitor (see page 114).	▸ *During measuring operation:* Check sample gas feed (filter, valves, lines, etc.) ▸ *During a calibration:* Check calibration gas feed (gas cylinders, setting of the pressure reducer, valves, etc.).	Only appears for devices with option "flow monitor". When the flow is lower than 50 % of the limit value, FAULT: flow is displayed.
SERVICE: Sensor x (x = 1 ... 3)	The measured values originating from the analyzer module may be wrong (i.e. do not correspond to the real concentration).	▸ Check whether the real concentration of the measuring components could actually be very high at the moment. ▸ *If this is the case:* Contact the manufacturer's Customer Service or trained skilled persons.	Criterion for message: Current measuring signal of analyzer module is higher than 120 % of the programmed A/D transducer dynamic range.
SERVICE: sensor ext.x (x = 1 ... 2)	The measured value which represents the internally processed measuring signal from analog input INx (see "Analog inputs", page 58) will be processed with a larger drift compensation.	Zero point drift or sensitivity drift of the measuring signal is 100 ... 120 % of the set drift limit value (see page 137).	
SERVICE: S-Drift #x (x = 1 ... 5)	The drift determined for measuring component x during the last calibration is above the set drift limit value.	Measuring function of the S700 is not yet restricted.	When the drift is higher than 120 % of the set drift limit value (see page 137), FAULT: ...-Drift x is reported.
SERVICE: Z-Drift #x (x = 1 ... 5)			
Start control x (x = 1 ... 4)	Internal controller 4 is trying to establish the nominal value.	Not a fault. This message will disappear for controller 1/2/3 within 30 minutes after power-on.	Controller 4 is currently not in use (reserve for future applications).

13.4 If the measured value is obviously incorrect ...

Possible causes	Notes	Notes for service
The S700 is not ready for operation.	– Start-up procedure see page 66 – Display of status/malfunction messages see page 77	–
The S700 is not measuring the sample gas. The sample gas path is not activated correctly.	▸ Check the sample gas path and all the valves (for example, switching from test gas to sample gas).	▸ Make sure that the valves are functioning correctly, disassemble if necessary.
The S700 is not correctly calibrated.	▸ Check if the calibration requirements are fulfilled: – Test gases correct? (see "Calibration gases", page 125) – Nominal values correctly set? (see "Setting the nominal values for the calibration gases", page 136). ▸ Then run a calibration.	▸ Carefully check the test gases you are using (nominal values, manufacturing tolerances, state, age).
The "damping" value is set too high for your application.	▸ Check setting (see "Setting damping (rolling average value computation)", page 88); possibly change as test.	–
The sample gas pressure inside the S700 is too high.	▸ Ensure that the sample gas pressure is in an allowable range (see "Gas technical requirements", page 216).	The gas pressure can influence the measured values in most of the measuring principles used.
The sample gas path is not gas-tight.	▸ Visually inspect the installation. ▸ *When a defect is suspected:* Inform the manufacturer's Customer Service or trained skilled persons.	Leak tightness check, see page 176.
When only observed on one measured value output: The load is too high.	▸ Make sure that the total internal resistance of the connected devices is not larger than 500 Ω.	▸ Measure including the connecting line.
The analyzer module is dirty.	▸ Contact manufacturer's Customer Service or trained skilled persons.	▸ Inspect the measuring cell/ cuvette. ▸ Clean or replace if necessary.
With option "external cross-sensitivity compensation": Fed analog signal is erroneous.	▸ Check the external equipment providing the analog signal for cross-sensitivity compensation.	– Connection interrupted? – Problem with the external measurement? – External analyzer not calibrated?

13.5 If the measured values are unstable and you don't know why ...

Possible causes	Notes	Notes for service
High pressure fluctuations at the sample gas outlet.	▸ Install a separate vent line for the S700.	–
Strong mechanical vibrations.	▸ Check the ambient conditions where the S700 is installed.	–

14 Shutdown procedure

14.1 Shutdown procedure

A)Taking care of connected devices/systems

- The shutdown of the analyzer could affect external systems. Moreover, you may need to consider which switching logic is used for the switching outputs of the gas analyzer (see “Control logic”, page 97)
- If a data processing system is connected, it may be required to manually indicate a planned shutdown, so that the system will not interpret the shutdown as an analyzer malfunction.

▶ If required, inform the operators of connected equipment that you are planning a shutdown.
▶ Check if any automatic emergency measures could be triggered when you shutdown the analyzer.

B)Removing the sample gas

1. Stop the gas delivery to the S700.
2. Disconnect the S700 from the external sample gas paths so that the sample gas can no longer flow into the S700.
3. Purge all gas paths in the S700 for several minutes with a “dry” neutral gas – for example, with technical grade nitrogen or with a zero gas. It is recommended to include the peripheral gas paths in this purging operation.
4. Then close-off all S700 gas connections, or close the related valves in the purged gas line.

WARNING: Risk for your health
If the S700 has been used to measure poisonous or dangerous gases:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before disassembling any gas path components.

NOTE:
Gas analyzers heat the internal sample gas system to create constant internal temperatures (analyzer modules of the S700: approx. 50 °C). A side-effect is that condensation would not occur in the internal measuring system.
However, when the gas analyzer is taken out of operation, the internal temperature falls, and now condensation could occur inside the measuring system. This must be avoided because this can damage the measuring system or make it unusable.
The consequence is:
▶ Always purge the internal sample gas path with a “dry” neutral gas (for example, nitrogen) before shutting-down the analyzer.

C)Switch off power

▶ *S710/S711:* Switch off the main power switch on the rear of the enclosure (see Fig. 7, page 51) or disconnect the main power supply at an external location (external switch, fuse).
▶ *S715/S720 Ex/S721 Ex:* Disconnect the main power supply at an external location (external switch, fuse).

D)Provide correct storage conditions

▶ see “Correct storage”, page 193.

14.2 Disposal information

These subassemblies could contain materials which may require special disposal:

- *Electronics:* Electrolyte capacitors, tantalum capacitors
- *Display:* Liquid of the Liquid Crystal Display (LCD)
- *Sample gas paths:* Toxic materials in the sample gas could have been absorbed or trapped in the “soft” gas path material (e.g. hoses, sealing rings). Check if special procedures are required for the disposal of such components.
- *Analyzer modules* UNOR *and* MULTOR: For some applications, the measuring chamber (IR sensor) and the reference side of the cuvette are filled with a gas or gas mixture which is similar to the sample gas. Check if these could be toxic or dangerous gases; if in doubt, always ask the manufacturer before opening or destroying components.

WARNING: Risk for your health
If the S700 has been used to measure toxic or dangerous gases:
▶ Thoroughly purge all sample gas paths with a neutral gas (for example, with nitrogen) before disassembling any gas path components.

15 Storage, transport

15.1 Correct storage

- *When the S700 has been separated from gas lines:* Close off the S700 gas connections (with sealing plugs, if necessary with adhesive tape) to protect against moisture, dust or dirt penetrating the internal gas path.
- Cover the electrical connectors (dust-tight), for example with adhesive tape.
- Protect the keypad and display against sharp-edged objects. If necessary, cover the device with a protective material (for example: cardboard, Styrofoam).
- Select a dry and well-ventilated room for storage.
- Pack the device to protect it from liquids and dirt (for example, in a plastic bag).
- *When high air humidity can be expected:* Include a drying agent (SilicaGel) in the packing.
- *When the S700 is fitted with the OXOR-E Analyzer module:* Keep gas connections gas-tight during storage.

+i The service life of the O_2 sensor in the OXOR-E module is significantly shortened by contact with oxygen from the air, even if the S700 is switched off.

15.2 Correct transport

CAUTION: Risk of injuries and accidents
- Observe the safety information on transport (see “Safety notes on transport”, page 32).

- *Protective measures:* As described in “Correct storage”.
- ***Packing for shipping:***
  - Use a strong container which is completely padded on the inside.
  - Make sure that there is sufficient space between the analyzer and the walls of the container.
  - Fasten the analyzer securely in the container.
- *Documents shipped with the analyzer:* see “Shipping for repair”.

15.3 Shipping for repair

When sending the device for repair to the factory or to a service workshop, please include short information so that we can send back the repaired device as soon as possible:

- A detailed, clear description of the problem (single words are fine, but merely stating that “the device does not work” is of little help).
- The name of the our representative who is informed about the problem or with whom you have arranged transport to the workshop.
- The contact person in your company who can answer any questions that may arise.

Please add the information even if your matter has already been discussed with our Customer Service or a representative. Thank you!

16 Special notes

16.1 Special version "THERMOR 3K"

Only applies for S700 with the analyzer module THERMOR 3K.

16.1.1 Purpose of the "THERMOR 3K" version

Turbo-driven power generators can be filled with hydrogen, to achieve a better cooling. However, the gas filling must be monitored during operation and during replacement procedures because of these reasons:

- For maintenance work, the gas filling must temporarily be replaced by air. Because hydrogen + air would be an explosive mixture, H_2 is first replaced by CO_2, then CO2 is replaced by air. Refilling with hydrogen works vice-versa. These filling procedures need to be monitored.
- During operation, it must be guaranteed that no air has penetrated into the hydrogen filling.

To meet these requirements, the special S700 version "THERMOR 3K" was designed. The special version uses a THERMOR module and a special signal processing method. This enables the following measurements:

Table 22: Measuring components of the special version for turbo-generators

Name of meas. component	Meas. value output	Output range		
H2-CO2	OUT1	0 ... 100 vol.%	H_2	in CO_2
CO2-Air	OUT2	0 ... 100 vol.%	CO_2	in air
H2-Air	OUT3	80 ... 100 vol.%	H_2	in air

16.1.2 Special features of the “THERMOR 3K” version

Selection of the valid measuring component

As a result of the special measuring methods, only the measured values of the measuring component relevant in the current operational or filling phase are correct. The measured values of the other measuring components are not valid (negative or non-calibrated values).

Therefore, you must determine in which operational or filling phase the turbogenerator currently is, and then select the single “large” measuring display for the related measuring component (see “Large display for one selected component”, page 75). This selection also affects the measured value outputs of the other measuring components, which will display a constant “0 vol.%” signal.

> +i The combined display for all measuring components (see “Combined display for all components”, page 74) is not suitable for the THERMOR 3K measuring operation.

Remote selection control

- For a remote control of a single measuring component, the control inputs can be used with function “MBU output x” (see “Available control functions”, page 99). x corresponds to the associated measured value output (see Fig. 22, page 194).
- The selected measuring component (i.e. the active measured value output) can be indicated by status outputs (see “Available switching functions”, page 98).

Restrictive menu feature

As long as the large measuring display for a single measuring component is activated, all menus will be restricted to this measuring component (except for the `measuring display` menu). If the menu system should include all the measuring components, you must activate the combined display for all measuring components (see “Combined display for all components”, page 74).

Measured value outputs

- The measuring components are assigned to certain measured value outputs (see Fig. 22, page 194). This setting cannot be changed (see “Assigning measuring components”, page 93).
- The measured value outputs have only one output range (see “Selecting the output ranges”, page 95). These output ranges cannot be changed (see “Setting-up the output ranges”, page 94).
- Selecting the “large” measuring display for one measuring component effects that only the associated measured value output is active, while the other measured value outputs constantly display “0 vol.%”.

Calibration

Please observe the special information on correct calibration (see “Calibrating the special version THERMOR 3K”, page 157).

Firmware Update

The special features are included in the standard software. For a firmware update (see “Firmware update”, page 113), the standard software for the S700 series can be used.

16.2 Automatic compensations

CAUTION: Risk of wrong measurements

- *When the S700 is working with a cross-sensitivity or carrier gas composition:* Observe the information in this Section.

Otherwise wrong measured values could be produced.

16.2.1 Information on active compensations

Information in the documents delivered with the device

- Check whether a compensation for certain measuring components is specified in the documents delivered with the S700.

> Please check if your S700 measures both NO and SO_2 with one MULTOR module (see delivered information or print of the software configuration, line “sensor type”).
> If this applies, then this MULTOR module usually also measures the H_2O concentration and performs an H_2O cross-sensitivity compensation for SO_2 and NO – even if this feature is not specified in the information delivered with the analyzer.

Information in the analyzer

To get all the information on working compensations:

- Use the `print config.` function to print or transmit corresponding internal data (see “Printing internal configuration”, page 104).

These are the data involved (example):

```
Measuring component    :        SO2         CO         CO2          O2    Temp. C
Measuring compensation :          3          3           3           3          3
a                    : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
b                    : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
c                    : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
d                    : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
e                    : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
f                    : +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00 +0.000e+00
SO2                  :        OFF         No        OFF        OFF        OFF
CO                   :        Yes        OFF         No        OFF        OFF
CO2                  :        OFF        OFF        OFF         No        OFF
O2                   :        OFF        OFF        OFF        OFF        OFF
Temp. C              :        OFF        OFF         No        OFF        OFF
```

- The `measuring component` lines shows all S700 measuring components and in addition the temperature which can also be compensated for.
- The code in the `meas. compensation` line specifies the automatic compensation or mathematical calculation which is active for the measuring component (explanation and consequences, see Fig. 23, page 197).
- The lines `a` ... `f` display the factory-set mathematical parameters used for the measured value processing.
- The `yes`/`no`/`OFF` information specifies whether a cross-sensitivity effect was found for the respective measuring component during the manufacturing process:

`OFF`	A cross-sensitivity effect was not found – which means that a cross-sensitivity compensation is not required for this pair of gas components
`yes`	A cross-sensitivity effect was found and an automatic cross-sensitivity compensation was activated.
`no`	A cross-sensitivity effect was found but an automatic cross-sensitivity compensation was not activated.

16.2.2 Consequences of automatic compensations

During calibrations, the automatic compensations are *out of operation.* The following Table shows the available compensations and their consequences:

Table 23: Consequences of automatic compensations

<table>
<tr><th rowspan="2">Code</th><th rowspan="2">Automatic compensation or calculation</th><th colspan="2">Consequences ...</th></tr>
<tr><th>... for measurement</th><th>... for calibration</th></tr>
<tr><td>0</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td>1</td><td>External cross-sensitivity compensation for measuring component A with measured value X from analog input IN1 (see “Analog inputs”, page 58)</td><td rowspan="2">Measured values A and X must be synchronous.
Example: When the external measured value represents a gas component, then the sample gas must synchronously flow through the external gas analyzer and the response times of the external gas analyzer and the S700 must be equal.</td><td rowspan="2">Calibration gases for measuring component A must not contain the measuring component X.
Note: The setting of “calibration with cross-compensation” (see “Calibration of cross-sensitivity compensations (option)”, page 154) has no influence.</td></tr>
<tr><td>2</td><td>As code 1, however with measured value from analog input IN2</td></tr>
<tr><td>3</td><td>Cross-sensitivity compensation for measuring component A with internal meas. component X</td><td>– When X is an internal measured value: none
– When X represents a fed external measured value: See notes for codes 1 and 2.</td><td>Zero gas used for measuring component A must not contain measuring component X.</td></tr>
<tr><td>4</td><td>Mathematical cross-calculation of internal measured values A and X</td><td>This option creates a “virtual” measuring component V which is displayed like a real measuring component.</td><td>You cannot make calibrations for the measuring component V. The measured values of V are correctly calibrated when the measuring components A and X are correctly calibrated.</td></tr>
<tr><td rowspan="2">5</td><td>Carrier gas compensation for meas. component A with the internal measuring component X</td><td>None</td><td rowspan="2">Zero gas and test gases which are used for measuring component A must not contain measuring component X.</td></tr>
<tr><td>Carrier gas compensation + cross-sensitivity compensation for meas. component A with the internal measuring component X</td><td>– When X is an internal measured value: none
– When X represents a fed external measured value: See notes for code 1 and 2.</td></tr>
</table>

16.3 Notes on particular measuring components

16.3.1 Measuring component CO

Interfering effects: When an unsuitable NO_X converter is installed in the sample gas path, CO_2 can partly or totally be converted to CO. Thus wrong measured values would be produced for CO, although the gas analyzer is working correctly.

Remedy: Use a suitable NO_X converter (see “Disturbing effects with NOX converters”, page 202).

16.3.2 Measuring component CO_2

NO_X converter

Interfering effects: When a NO_X converter is installed in the sample gas path, CO_2 can under certain circumstances be partly or totally converted to CO. Thus, wrong CO_2 measured values would be produced, although the gas analyzer is measuring correctly.

Remedy: Use a suitable NO_X converter (see “Disturbing effects with NOX converters”, page 202).

Sample gas cooler

Interfering effects: When a sample gas cooler is used, some of the CO_2 could be dissolved in the condensate and thus be removed from the sample gas path. Thus, wrong CO_2 measured values would be produced, although the gas analyzer is measuring correctly.

Remedy: Install a condensate acidification (see “Disturbing effects with a sample gas cooler”, page 200).

16.3.3 Measuring component H_2O

Plastic gas lines

Interfering effects: Many plastic materials are permeable for gaseous H_2O. This means that in plastic gas lines a portion of the H_2O concentration could be lost or additional H_2O could enter the sample gas. This would cause wrong measured values although the gas analyzer is working correctly. This effect is particularly strong with PTFE.

Remedy: Use metal gas lines.

Sample gas cooler

Interfering effects: When a sample gas cooler is used, wrong measured values can occur when measurements and calibrations are performed in the wrong way.

Remedy: Observe the information in see “Disturbing effects with a sample gas cooler”, page 200 and see “Calibrations with a sample gas cooler”, page 201.

16.3.4 Measuring component O_2

Interfering effects: When the S700 measures the O_2 concentration with the analyzer module OXOR-P, the O_2 measured value can be falsified when the sample gas contains other gas components which have a high paramagnetic or diamagnetic susceptibility.

Remedy: Observe the information in see “Cross-sensitivity compensation with OXOR-P”, page 156.

16.3.5 Measuring component SO_2

H_2O cross-sensitivity

In the NDIR analysis of SO_2, an H_2O cross-sensitivity cannot be avoided due to strong overlapping of the absorption ranges. Thus the SO_2 analysis is generally “sensitive” against the H_2O concentration. In many cases this effect is so small that it does not reduce the specified measuring precision. In some cases, however, it is required to use H_2O cross-sensitivity compensation in order to maintain the specified measuring precision.

Sample gas cooler

Interfering effect: When a sample gas cooler is used, some of the SO_2 could be dissolved in the condensate and thus removed from the sample gas path. This would cause wrong SO_2 measured values, although the gas analyzer is working correctly.

Remedy: Install a condensate acidification (see “Disturbing effects with a sample gas cooler”, page 200).

Analysis of both SO_2 and NO in one MULTOR module

If the S700 measures both the SO_2 and NO concentration with a MULTOR module (see delivered information or “Information on active compensations”, page 196), then this MULTOR module usually also measures the H_2O concentration and performs an H_2O cross-sensitivity compensation for SO_2 and NO – even if this feature is not specified in the information delivered with the analyzer.

Measure: In this case, observe information in see “Calibration of cross-sensitivity compensations (option)”, page 154.

Analysis of SO_2 and NO in separate analyzer modules

If the S700 should measure both the SO_2 and NO concentration and a high sensitivity is required, then SO_2 and NO are measured in two separate analyzer modules (UNOR/UNOR or UNOR/MULTOR). In this case, an internal H_2O cross-sensitivity compensation is not possible.

Measures: Observe the information in see “Calibrating “H2O cross-sensitive” measuring components”, page 156.

16.3.6 Measuring component NO / NO_X

H_2O cross-sensitivity

As for SO_2, the NDIR gas analysis of NO cannot avoid an H_2O cross-sensitivity, due to strong overlapping of the absorption ranges. The NO analysis is therefore generally “sensitive” against the H_2O concentration – as long as no H_2O cross-sensitivity compensation is active. Please observe the following notes:

Analysis of both NO and SO_2 in one MULTOR module

see “Measuring component SO2”

Analysis of NO and SO_2 in separate analyzer modules

see “Measuring component SO2”

NO_X converter

see “Disturbing effects with NOX converters”, page 202

16.4 Information on using a sample gas cooler

16.4.1 Purpose of a sample gas cooler

No condensation may occur in the internal gas paths of a gas analyzer. Condensation can occur when the sample gas temperature at the sampling point is higher than in the gas analyzer and the sample gas contains condensable gas components – for example, H_2O in the exhaust gas of a combustion plant.

In such cases, the temperature of the sample gas must be lowered once, prior to feeding into the analyzer, in order to lower the dew point (= the temperature where condensation occurs). Usually, a sample gas cooler is used here where the temperature of the flowing sample gas is significantly decreased; this removes most of the condensable components from the gas.

However, the condensable components will not be removed completely. You might need to consider this fact in some applications in order to produce correct measured values (see “Disturbing effects with a sample gas cooler”). For H_2O, the remaining concentration is approximately 7000 ... 11000 ppm, depending on the cooler temperature (see Table 12, page 153).

16.4.2 Disturbing effects with a sample gas cooler

Disturbing effect with an “H_2O-sensitive” analysis

If the S700 measures at least one measuring component which has a cross-sensitivity against H_2O and an automatic H_2O cross-sensitivity compensation is *not* active, then the measured values can be affected by physical changes in the sample gas cooler.

Remedy: Ensure a constant state of the sample gas cooler.

Disturbing effect with water-soluble gases (for example, CO_2, SO_2)

Inside the sample gas cooler, there is a relatively large surface of condensed water. That has a consequence for gases which have a physical or chemical high solubility in water (for example, CO_2, SO_2): A portion of such a gas component would be dissolved in the condensate and thus removed from the sample gas. This means that the measured value would be smaller – although the gas analyzer is working correctly. The lower the real gas concentration is, the greater the relative measuring error. This also affects the calibration of such gas components, if the calibration gases are flowing through the sample gas cooler (see “Calibrations with a sample gas cooler”, page 201).

Remedy: If the dissolved gas creates an acid with water, minimize the interfering effect by acidifying the condensate in the sample gas cooler with this acid and keeping the pH level in the sample gas cooler permanently below pH 2. In this way, the condensate will be “saturated” and thus will not absorb the respective gas. To do this, you need to feed the respective acid (for example, H_2CO_3, H_2SO_3) into the gas path of the sample gas cooler. Please note that the sample gas cooler needs to be corrosion-resistant.

Disturbing effect due to drying-out in the course of long calibration procedures

Calibration gases from gas cylinders are usually “dry”, which means they practically do not contain H_2O. When such calibration gases are flowing through the sample gas cooler for a certain time, the cooler could dry out. This extreme change of state can cause an incorrect calibration – especially for “H_2O-sensitive” measuring components.

Remedy: Produce “wet” calibration gas. To do this, install a suitable vessel in the gas path, filled with water, and let the calibration gases bubble through the vessel before they are fed into the sample gas cooler.

16.4.3 Calibrations with a sample gas cooler

Correct calibrations with “internal H_2O cross-sensitivity compensation”

If the S700 is working with an “internal H_2O cross-sensitivity compensation” (option), then all of the calibration gases should flow through the sample gas cooler before they are fed into the analyzer (exemplary flow schedule, see Fig. 3, page 37).

The only exceptions to this rule apply to:

- the zero point calibration of the measuring component H_2O (see “Calibration of the H2O measurement”, page 151)
- the calibration of the cross-sensitivity compensations (see “Calibration of cross-sensitivity compensations (option)”, page 154).

Consequences of “wet” calibration gases

For this method, let the calibration gases flow through the sample gas cooler – in the same way as the sample gas before they reach the gas analyzer.

Thus, the calibration gases are changed in the same way as the sample gas in the sample gas cooler. Advantage: The current influence of the sample gas cooler is recorded physically and considered in the calibration; the influence on H_2O cross-sensitivity effects (if existing() is also considered physically in this way.

However, there are some disadvantages with this method:

- Because the physical conditions in the sample gas cooler are not exactly constant, the results of several calibrations might not be exactly identical. This means that you could not evaluate the gas analyzer drift by direct comparison of individual calibrations against each other.
- Because calibration gases from gas cylinders practically do not contain any H_2O, the sample gas cooler could dry out in the course of a long calibration procedure. This would neutralize the advantage of this method (remedy, see “Disturbing effects with a sample gas cooler”, page 200).

Consequences of “dry” calibration gases

If the calibration gases are fed directly into the gas analyzer without being led through the sample gas cooler, the calibration results can be reproduced. This allows, for example, monitoring gas analyzer drift.

Disadvantage of this method: The calibrations would not consider the influence of the sample gas cooler. It may be necessary to quantify the influence of the sample gas cooler. Perform measurements using calibration gases instead of the sample gas. Feed the calibration gases in once directly (the same way as for calibration) and once through the sample gas cooler (the same way as the sample gas). Consider the differences in measuring operation. It might be advisable to repeat these reference measurements from time to time.

16.5 Information on using a NO_X converter

16.5.1 Purpose of NO_X converters

If the NO concentration is measured and the sample gas also contains NO_2, some applications may require the measurement of the NO_2 portion in combination with the NO portion. This can be done by installing a “NO_X converter” in the sample gas path. A NOX converter provides a thermal-catalytic process which converts NO_2 to NO. Thus an NO gas analyzer will actually determine the “NO_X” concentration ($NO_X = NO + NO_2$).

16.5.2 Disturbing effects with NO_X converters

Thermal re-conversion

The thermal NO_2 conversion is reversible. This means that the conversion effect can be partially lost when the sample gas is allowed to cool down strongly before it reaches the gas analyzer.

Remedy: Ensure that the gas path between NO_X converter and gas analyzer is as short as possible.

Conversion of other gases

Other gases could possibly be converted in the same way. This applies to CO/CO_2, for example. An unwanted conversion would distort the analysis of such measuring components.

Remedy: Use a low-temperature NO_X converter with a molybendum catalyst when your S700 is also measuring CO and/or CO_2. If you use a high-temperature converter or a converter with a graphite catalyst, the measured values of the CO and CO_2 analysis would be not be correct.

16.6 Interface connection with a PC

16.6.1 Creating an interface connection

Connecting a single analyzer directly via the interface

This connection requires at least three electrical lines (TXD → RXD, RXD → TXD, GND → GND; see Fig. 10, page 159). Short out the CTS–RTS and DSR–DTR connections on the PC (install wire bridges in the plug connector of the connecting cable; see Figure). To use the “RTS/CTS protocol” for data transmissions (Windows designation: “Protocol: Hardware”), install three further connection lines (see Figure); the shorting jumpers are then not required.

Connecting several analyzers via BUS converters

In order to control several gas analyzers from one PC, you will need a RS422 BUS connection (see Fig. 10, page 159). Each connected device will need one RS232C/RS422 BUS converter. These are available from various manufacturers.

The BUS converter which is connected to the PC must work as “data circuit-terminating equipment” (DCE). The BUS converters connected to the gas analyzers must work as “data terminal equipment” (DTE). Many BUS converters allow you to select between these modes. Set-up the BUS converters accordingly or use the appropriate BUS converter versions. – Most BUS converters need an external power supply (not shown in the figure).

When using BUS converters, the “RTS/CTS protocol” must be activated in the gas analyzer (see “Digital interface parameters”, page 101).

Connecting a single analyzer via modems

Modems enable the data transmission via telephone lines; two modems are needed for the connection (see Fig. 28, page 205). You can use any type of modem which has a Hayes-compatible command set. – Menu functions for setting the correct modem parameters are available in the S700.

Connecting several analyzers via BUS converters and modems

This version combines modems and BUS converters (see Fig. 28, page 205). Please refer to the notes above.

> +i Which type of connection will be used must be programmed in the S700 (see “Setting the installed connection”, page 106).

Fig. 27: Connection of gas analyzer and PC, without modems

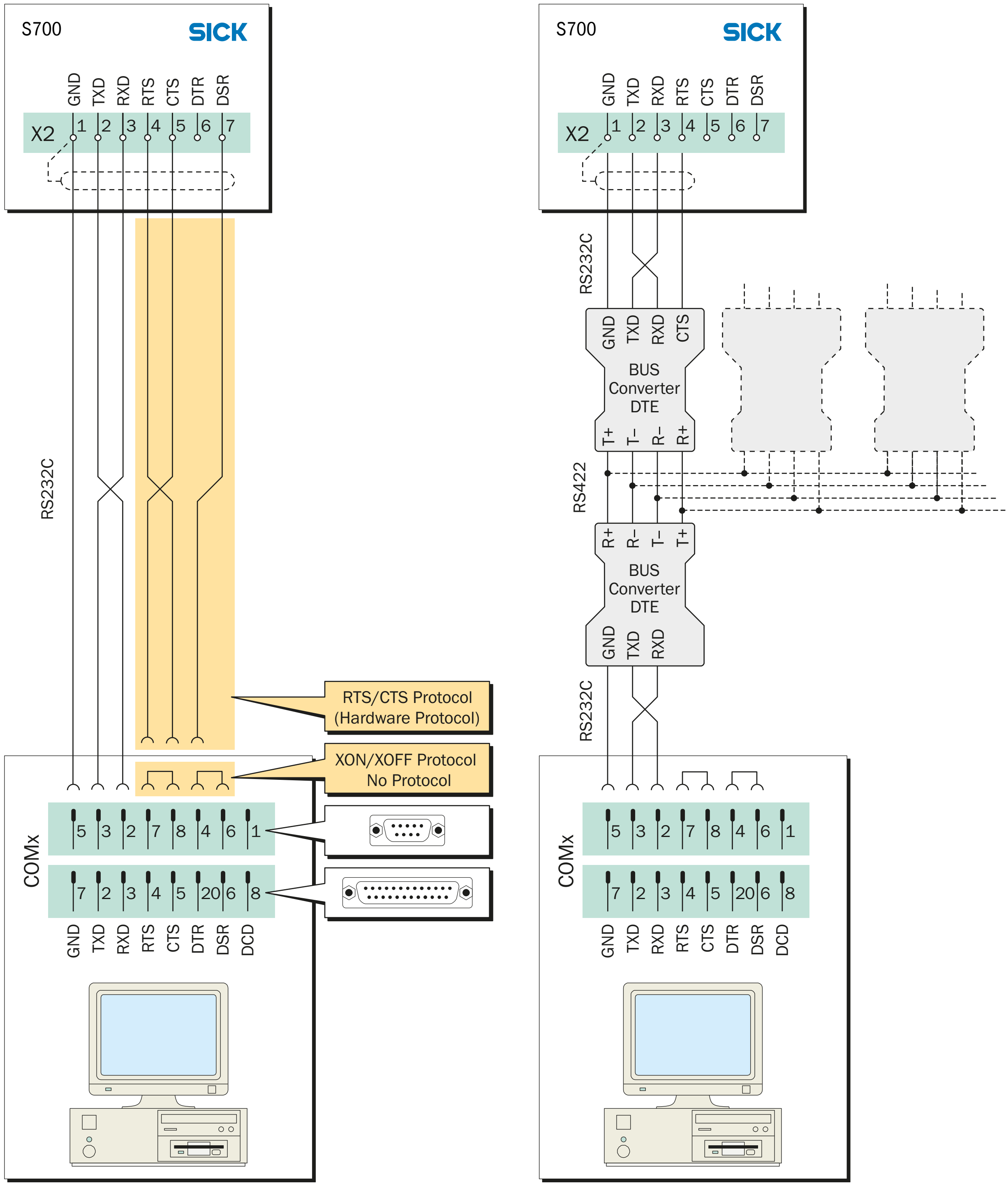
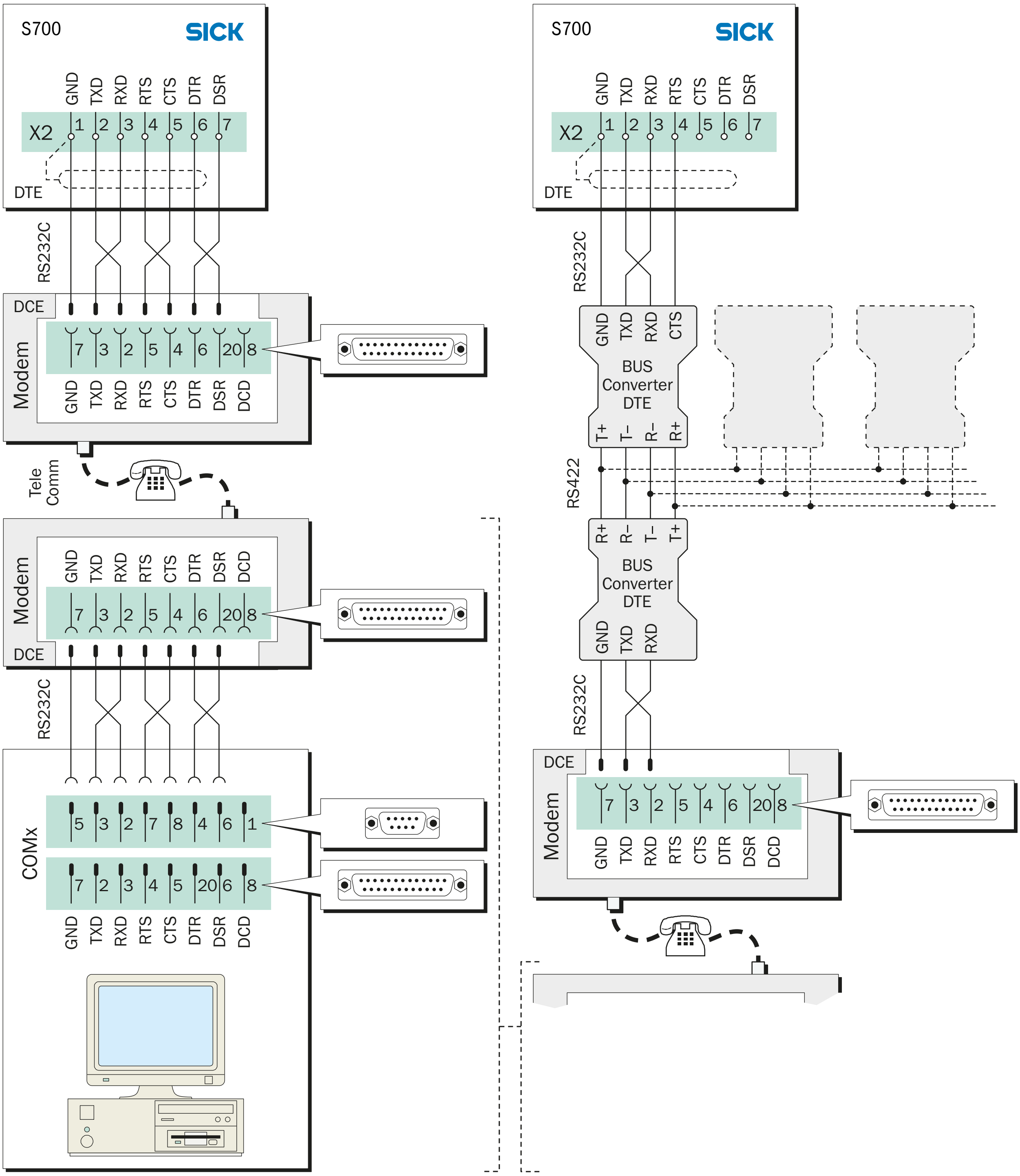


Fig. 28: Connection of gas analyzer and PC via modems



16.6.2 Setting interface parameters (overview)

Basic settings

1 Set-up the interface parameters on interface #1 to match those on the connected PC or modem (see “Digital interface parameters”, page 101).
2 Set-up the installed electrical connection (see “Setting the installed connection”, page 106).

Settings for operation with modems

▶ Set-up the basic modem functions (see “Configuring the modem connection”, page 107).

Settings for operation with BUS converters

1 Activate the “RTS/CTS protocol” (see “Digital interface parameters”, page 101).
2 Set-up an individual identification character for each of the connected gas analyzers (see “Setting the ID character”, page 105).
3 Activate `AK-ID-active` (see “Activating the ID character / Activating Modbus”, page 106).

When using BUS converters:
▶ Make all the remote control settings ***identical*** in all the connected gas analyzers – except for the identification character.

17 Custom configuration tables

17.1 User Table: Measuring components and calibration gases

☐ S710 ☐ S711 ☐ S715 ☐ S720 Ex ☐ S721 Ex	Device no.:

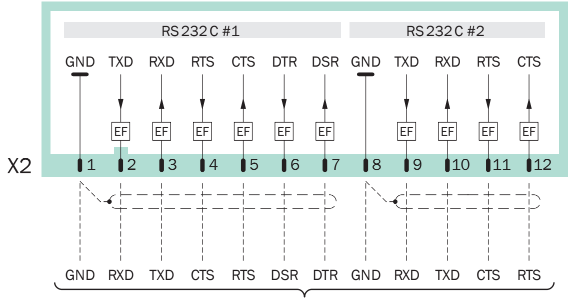
		Measuring component					Remarks
		1	2	3	4	5	
Name/Formula:							
Measured with the analyzer module:		☐ FINOR ☐ UNOR ☐ MULTOR ☐ OXOR-P ☐ OXOR-E ☐ THERMOR ☐	☐ FINOR ☐ UNOR ☐ MULTOR ☐ OXOR-P ☐ OXOR-E ☐ THERMOR ☐	☐ FINOR ☐ UNOR ☐ MULTOR ☐ OXOR-P ☐ OXOR-E ☐ THERMOR ☐	☐ FINOR ☐ UNOR ☐ MULTOR ☐ OXOR-P ☐ OXOR-E ☐ THERMOR ☐	☐ FINOR ☐ UNOR ☐ MULTOR ☐ OXOR-P ☐ OXOR-E ☐ THERMOR ☐	
Physical unit for the measured value:		☐ ppm ☐ vol.-% ☐ mg/m³ ☐ g/m³ ☐	☐ ppm ☐ vol.-% ☐ mg/m³ ☐ g/m³ ☐	☐ ppm ☐ vol.-% ☐ mg/m³ ☐ g/m³ ☐	☐ ppm ☐ vol.-% ☐ mg/m³ ☐ g/m³ ☐	☐ ppm ☐ vol.-% ☐ mg/m³ ☐ g/m³ ☐	
Nominal values for calibration gases	Zero gas 1						
	Zero gas 2						
	Test gas 3						
	Test gas 4						
	Test gas 5						
	Test gas 6						

17.2 Signal connection overview

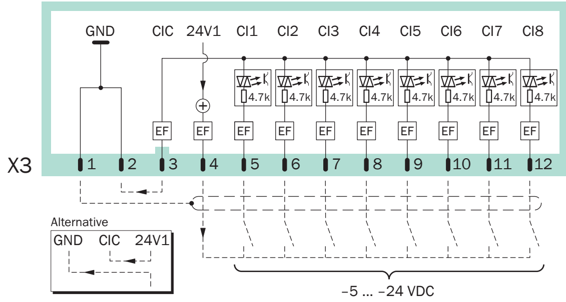
NOTE:

- Use this overview only if you are familiar with the related comprehensive safety information (see references in the illustration).

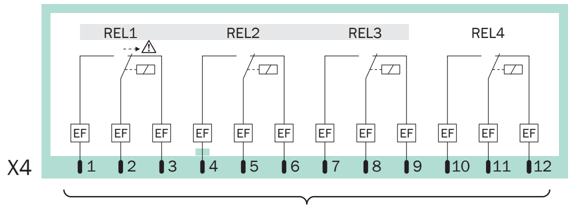
Fig. 29: Signal connection overview



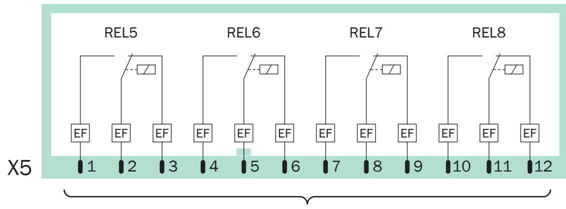
see page 65
see page 102
see page 65



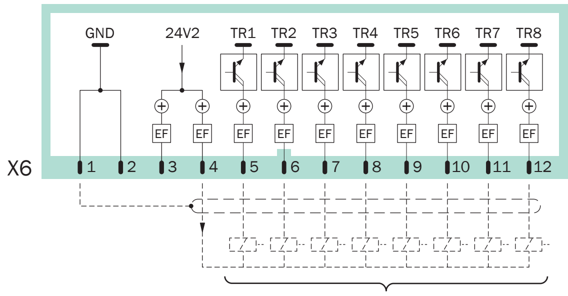
see page 62
see page 99
see page 61
see page 210



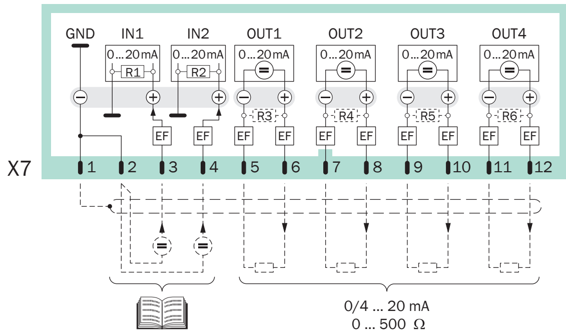
see page 59
see page 97
see page 60
see page 209



see page 59
see page 97
see page 60
see page 209



see page 59
see page 97
see page 61
see page 209



see page 57
see page 96
see page 58

17.3 User Table: Switching outputs

☐ S710 ☐ S711 ☐ S715 ☐ S720 Ex ☐ S721 Ex	Device no.:

Function (explanation, see “Available switching functions”, page 98)		REL1		REL2		REL3		REL4		REL5		REL6		REL7		REL8		TR1		TR2		TR3		TR4		TR5		TR6		TR7		TR8	
Name	Code	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!
failure	1	–	X	–	–	–	–																												
service	2	–	–	X	–	–	–																												
fault	3	–	–	–	–	X	–																												
alarm limit 1	4	–	–	–	–	–	–																												
alarm limit 2	5	–	–	–	–	–	–																												
alarm limit 3	6	–	–	–	–	–	–																												
alarm limit 4	7	–	–	–	–	–	–																												
External pump	8	–	–	–	–	–	–																												
calibration active	9	–	–	–	–	–	–																												
auto. calibration	10	–	–	–	–	–	–																												
zero gas path 1	11	–	–	–	–	–	–																												
zero gas path 2	12	–	–	–	–	–	–																												
test gas path 3	13	–	–	–	–	–	–																												
test gas path 4	14	–	–	–	–	–	–																												
test gas path 5	15	–	–	–	–	–	–																												
test gas path 6	16	–	–	–	–	–	–																												
sample gas path	17	–	–	–	–	–	–																												
range – output 1	18	–	–	–	–	–	–																												
range – output 2	19	–	–	–	–	–	–																												
range - output 3	20	–	–	–	–	–	–																												
range - output 4	21	–	–	–	–	–	–																												
switch on pt. 1	22	–	–	–	–	–	–																												
switch on pt. 2	23	–	–	–	–	–	–																												
switch on pt. 3	24	–	–	–	–	–	–																												
switch on pt. 4	25	–	–	–	–	–	–																												
switch on pt. 5	26	–	–	–	–	–	–																												
switch on pt. 6	27	–	–	–	–	–	–																												
switch on pt. 7	28	–	–	–	–	–	–																												
switch on pt. 8	29	–	–	–	–	–	–																												
meas. value pt. 1	30	–	–	–	–	–	–																												
meas. value pt. 2	31	–	–	–	–	–	–																												
meas. value pt. 3	32	–	–	–	–	–	–																												
meas. value pt. 4	33	–	–	–	–	–	–																												
meas. value pt. 5	34	–	–	–	–	–	–																												
meas. value pt. 6	35	–	–	–	–	–	–																												
meas. value pt. 7	36	–	–	–	–	–	–																												
meas. value pt. 8	37	–	–	–	–	–	–																												
FAILURE sensor 1	38	–	–	–	–	–	–																												
FAILURE sensor 2	39	–	–	–	–	–	–																												
FAILURE sensor 3	40	–	–	–	–	–	–																												
FAILURE extern 1	41	–	–	–	–	–	–																												
FAILURE extern 2	42	–	–	–	–	–	–																												
SERVICE sensor 1	43	–	–	–	–	–	–																												
SERVICE sensor 2	44	–	–	–	–	–	–																												
SERVICE sensor 3	45	–	–	–	–	–	–																												
SERVICE extern 1	46	–	–	–	–	–	–																												
SERVICE extern 2	47	–	–	–	–	–	–																												
CALIBR. sensor 1	48	–	–	–	–	–	–																												
CALIBR. sensor 2	49	–	–	–	–	–	–																												
CALIBR. sensor 3	50	–	–	–	–	–	–																												
CALIBR. extern 1	51	–	–	–	–	–	–																												
CALIBR. extern 2	52	–	–	–	–	–	–																												
Flow sensor	53	–	–	–	–	–	–																												
Condensate sensor	54	–	–	–	–	–	–																												
Measured value output 1	55	–	–	–	–	–	–																												
meas.value output2	56	–	–	–	–	–	–																												
meas.value output3	57	–	–	–	–	–	–																												

17.4 User Table: Control inputs

☐ S710 ☐ S711 ☐ S715 ☐ S720 Ex ☐ S721 Ex	Device no.:

Control function f (see "Available control functions", page 99)		CI1		CI2		CI3		CI4		CI5		CI6		CI7		CI8	
Name	Code	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!	f	f-1!
service block	1																
auto.cal. 1 start	2																
auto.cal. 2 start	3																
auto.cal. 3 start	4																
auto.cal. 4 start	5																
cal. stop	6																
pump on/off	7																
zero gas 1 fault	8																
test gas 3 fault	9																
test gas 4 fault	10																
test gas 5 fault	11																
range – output 1	12																
range – output 2	13																
range - output 3	14																
range - output 4	15																
(no function)	16																
failure 1	17																
failure 2	18																
service 1	19																
service 2	20																
fault 1	21																
fault 2	22																
no drifts	23																
sample value hold	24																
zero gas 2 fault	25																
test gas 6 fault	26																
hold sample pt. 1	27																
hold sample pt. 2	28																
hold sample pt. 3	29																
hold sample pt. 4	30																
hold sample pt. 5	31																
hold sample pt. 6	32																
hold sample pt. 7	33																
hold sample pt. 8	34																
switch off pt. 1	35																
switch off pt. 2	36																
switch off pt. 3	37																
switch off pt. 4	38																
switch off pt. 5	39																
switch off pt. 6	40																
switch off pt. 7	41																
switch off pt. 8	42																

18 Technical data

18.1 Enclosure

18.1.1 Dimensions

Fig. 30: Enclosures S710/S711

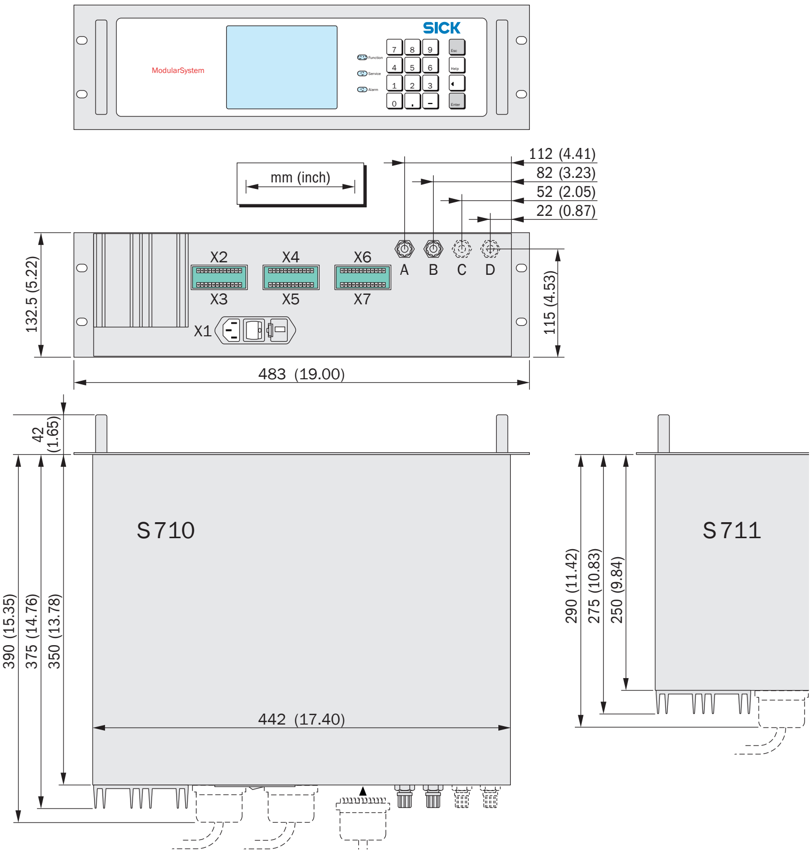


Fig. 31: Enclosure S715

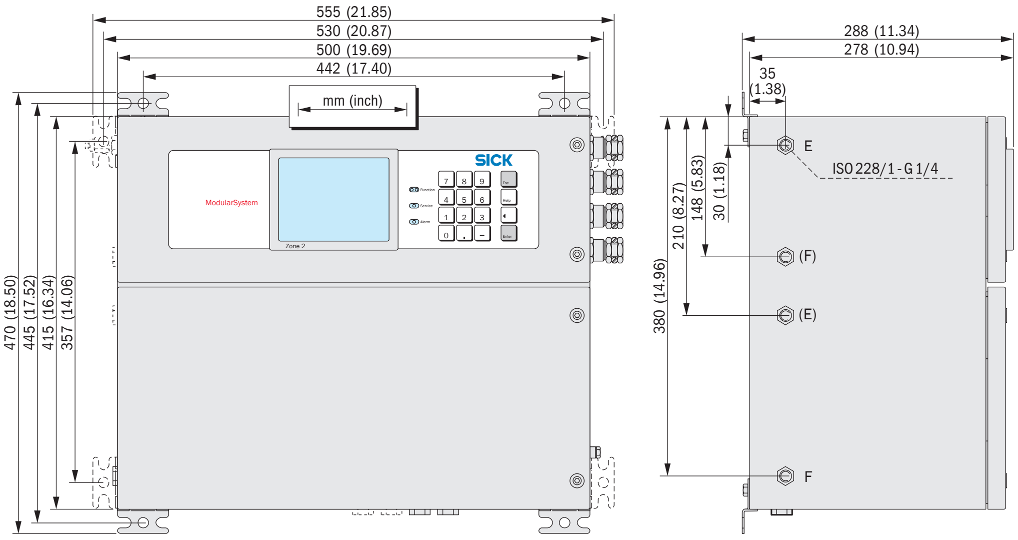
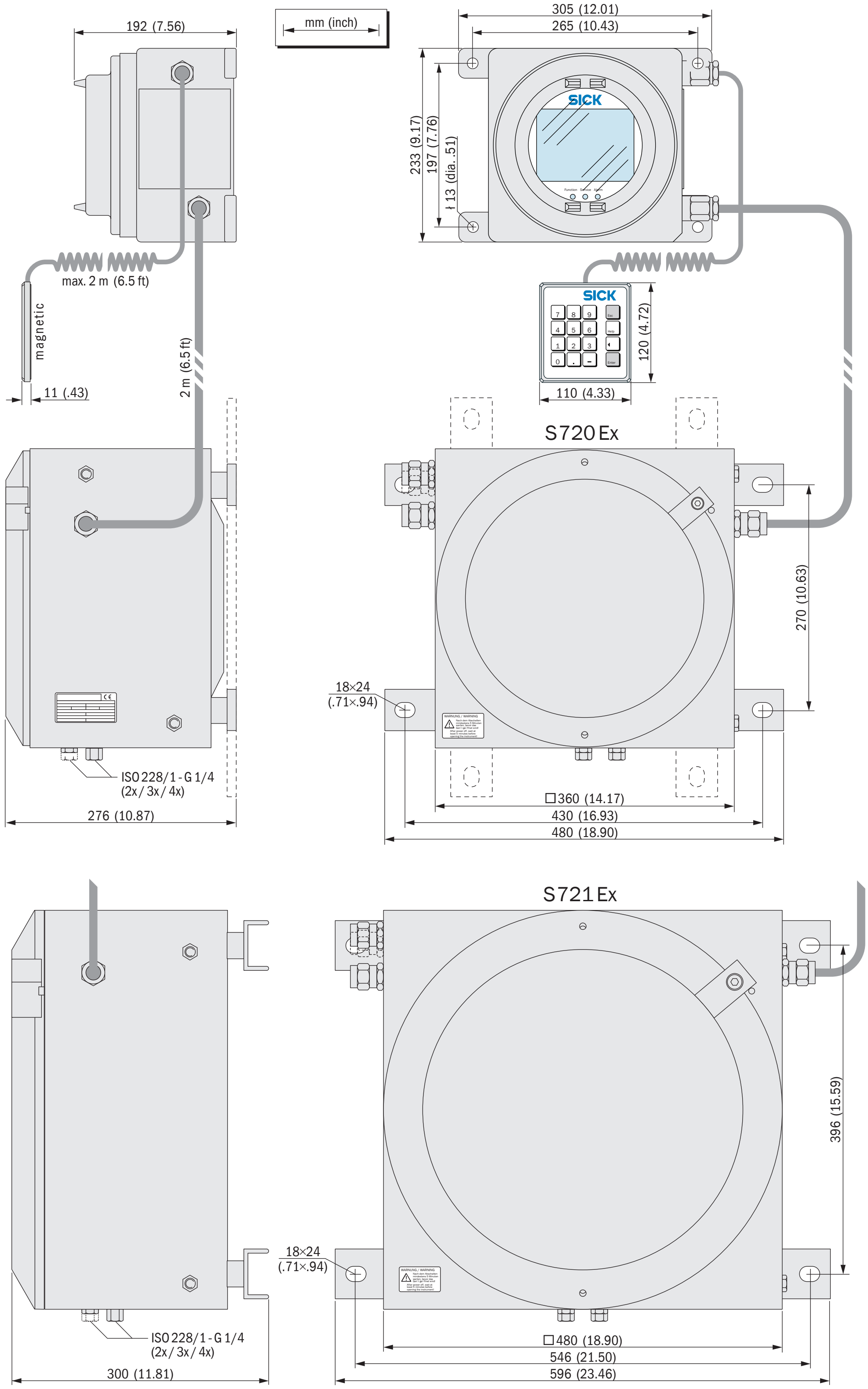


Fig. 32: Enclosure S720 Ex/S721 Ex



18.1.2 Enclosure specifications

Enclosure type	Weight	Protection class [1]	Explosion protection (identification)
S710 S710 CSA	10 ... 20 kg [2]	IP 20	–
S711 S711 CSA	9 ... 19 kg [2]		
S715 standard S715 CSA	20 ... 30 kg [2]	IP 65 (Nema 4X)	
S715 EX	20 ... 30 kg [2]	IP 65 (Nema 4X)	*Without intrinsically-safe measured value outputs:* II 3 G Ex nR IIC T6 Gc *With intrinsically-safe measured value outputs:* [3] II 3 G Ex nR [ib] IIC T6 Gc
S715 EX CSA	20 ... 30 kg [2]	IP 65 (Nema 4X)	Class I, Division 2, Groups A, B, C, and D, T6
S720 Ex	60 ... 70 kg [2]	IP 65 (Nema 7)	*Without intrinsically-safe measured value outputs:* II 2 G Ex db ib IIC T6 Gb *With intrinsically-safe measured value outputs:* [3] II 2 G Ex db ib [ib] IIC T6 Gb
S721 Ex	90 ... 100 kg [2]		

[1] EN 60529
[2] depending on the internal equipment
[3] Option

18.1.3 Gas connections

Sample gas and span gas connections

Enclosure type	Standard gas connection	Optional
S710 S711	• PVDF bulkhead fitting for 6x1 mm hose	• “Swagelok” fitting for 6 mm tube • “Swagelok” fitting for 1/4" tube
S715 S720 Ex S721 Ex	• internal (female) thread G¼" [1]	• PVDF bulkhead fitting for 6x1 mm hose • “Swagelok” fitting for 6 mm tube • “Swagelok” fitting for 1/4" tube

[1] to be used for screw-in fittings

Purge gas connections

Enclosure type	Standard connection	Optional
S715	• internal thread G¼"	• “Swagelok” fitting for 8 mm tube • “Swagelok” fitting for 10 mm tube • “Swagelok” fitting for 3/8" tube
S720 Ex S721 Ex	• internal thread G¼"	–

18.2 Ambient conditions

Installation site · Assembly	
Atmospheric influences:	The device is intended only for indoor use
Vibrations/impacts:	The installation site should be free from vibrations and impacts
Position of use (allowed inclination of housing during operation):	Max. ±15° inclination [1]to each spatial axis

[1] Keep stable during operation; perform a new calibration after changes in the inclination.

Pressure · Temperature	
Geographic altitude of installation site:	Max. 2000 m above sea level (approx. 750 hPa)
Ambient air pressure:	700 ... 1200 hPa
Operating temperature:	+5 ... +45 °C (41 ... 113 °F)
Storage temperature:	–20 ... +70 °C (–4 ... +158 °F)

Humidity · Dirt	
Relative humidity:	– annual average: ≤ 75 % (short-term: ≤ 95%) – non-condensing – humidity class F (DIN 40040)
Permissible contamination:	– S710, S711: Degree of contamination 1 [1] – S715, S720 Ex, S721 Ex Degree of contamination 3 [2]

[1] No contamination or only dry, nonconductive contamination
[2] Dry and wet contamination that can be electrically conductive.

18.3 Electrical specifications

Power connection	
Power voltage [tolerance], power voltage frequency	
– standard:	100 V AC *or*[1] 115 V AC *or* 230 V AC [– 15 % ... + 10 %], 48 ... 62 Hz
– CSA versions:	115 V AC [– 10 % ... + 15 %], 60 Hz *or*[1] 230 V AC [– 15 % ... + 10 %], 50 Hz
Permissible overvoltages:	Transient overvoltages in the supply network should not exceed overvoltage category II according to IEC 60364-4-443
Power input:	
– standard:	50 VA
– with maximum equipment:	150 VA

[1] Can be selected mechanically (see “Adapting to power voltage”, page 184); adaption of mains fuse required (see “Internal fuses”, page 185).

Electrical safety	
Class of protection:	Class of protection I [1]
Electrical safety:	Checked according to EN 61010 (VDE 411) Low Voltage Directive 72/73/EEC
Transformer:	Safety transformer according to EN 61558 (VDE 0570)
Electromagnetic compatibility:	According to EN 61326 and EN 61000 EMC Directive 89/336/EEC

[1] VDE 0411 Part 1 / IEC 348

Battery (memory buffer)	
Expected service life:	10 years

18.4 Measuring characteristics

Response behavior	
Warm-up time:	120 minutes
Response time t_{90}:	< 45 s [1]

[1] when sample gas flow = 60 l/h and damping time constant ($t_{90\ electr.}$) = 15 s

Influencing variables	
Influence of atmospheric air pressure:	≤ 1 % [1]

[1] with option “barometric pressure compensation”

18.5 Gas technical requirements

Sample gas properties	
Permissible sample gas temperature: [1]	0 ... 45 °C (32 ... 113 °F)
Permissible sample gas dew point:	Below ambient temperature
Particles in the sample gas:	Sample gas should be free from dust and aerosols [2]
Permissible sample gas pressure [3]	
– internal gas paths hose-connected:	–20 ... +30 kPa (–200 ... +300 mbar) [4]
– internal gas paths tube-connected:	–20 ... +100 kPa (–200 ... +1000 mbar) [5]
– with analyzer module “OXOR-E”:	–20 ... +30 kPa (–200 ... +300 mbar)
– S720 Ex/S721 Ex:	–20 ... +10 kPa (–200 ... +100 mbar)
Sample gas flow [1]	
– minimum:	5 l/h (85 cm^3/min)
– maximum:	100 l/h (1660 cm^3/min)
– recommended:	30 ... 60 l/h (500 ... 1000 cm^3/min)
– standard:	60 l/h (1000 cm^3/min)

[1] should be constant during operation
[2] when entering the gas analyzer
[3] relative to the ambient/atmospheric air pressure
[4] *Exception:* S720 Ex/S721 Ex (see below).
[5] *Exceptions:* With analyzer module “OXOR-E”, S720 Ex/S721 Ex (see below).

Built-in gas pump (option)	
Type of construction:	Oscillating diaphragm pump
Flow rate: [1]	max. 60 l/h (with 100 hPa pressure difference)

[1] pump power is adjustable via menu (see “Setting the capacity of the gas pump”, page 114)

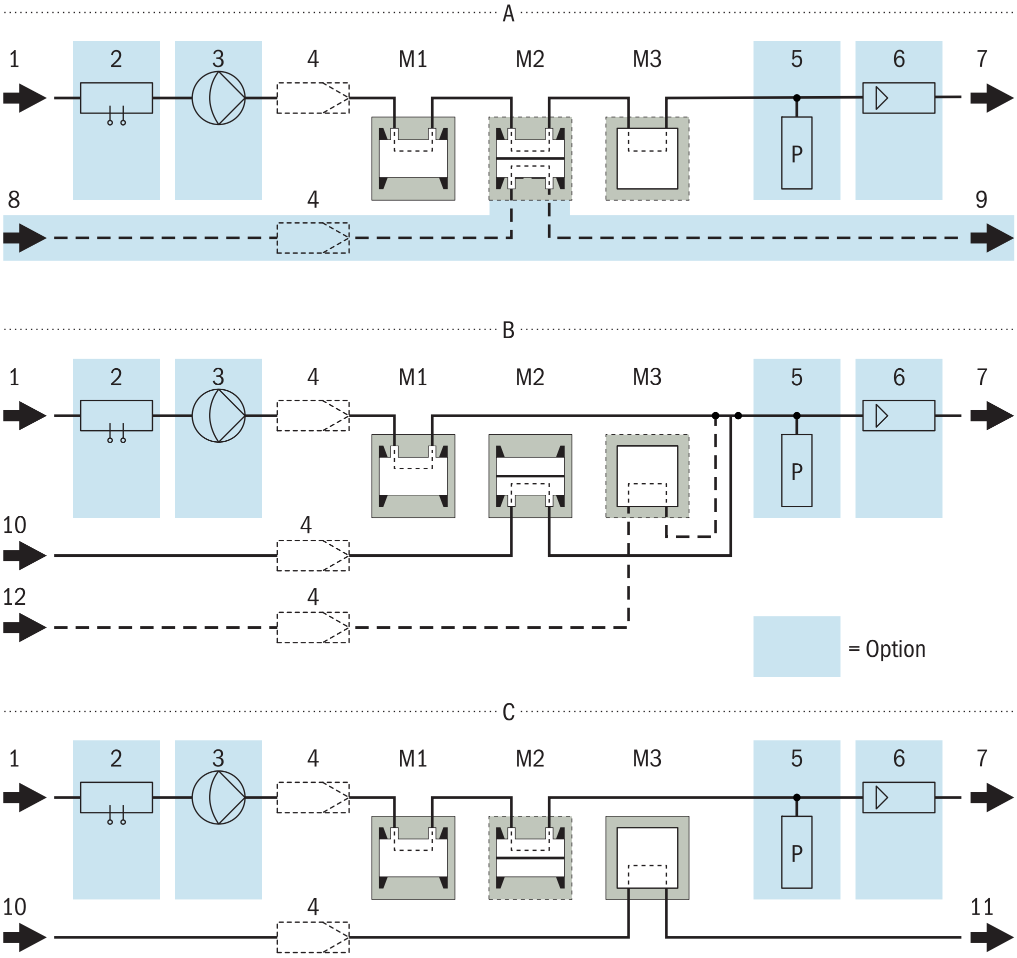
Subject to change without notice

18.6 Internal gas path

18.6.1 Flow plan

The internal gas path depends on the number and type of the built-in analysis modules and on the desired configuration. Standard flow schematics are shown in "Internal gas flow (standard flow schematics)". Other configurations are possible according to customer and application requirements.

Fig. 33: Internal gas flow (standard flow schematics)



-A-	Analyzer module serial: 1 sample gas path (option: 1 span gas path)		
-B-	Analyzer module parallel: 2 or 3 sample gas inlets, 1 sample gas outlet		
-C-	Two sample gas paths, completely separated		
M1	Analyzer module #1 (Standard: UNOR, MULTOR, FINOR)		
M2	Analyzer module #2 (Standard: UNOR, MULTOR)		
M3	Analyzer module #3 (Standard: OXOR, THERMOR)		
1	Sample gas inlet	7	Sample gas outlet
2	Condensate sensor	8	Span gas inlet
3	Gas pump	9	Span gas outlet
4	Safety filter	10	Second sample gas inlet
5	Pressure sensor	11	Second sample gas outlet
6	Flow sensor	12	Third sample gas inlet

18.6.2 Materials in contact with the sample gas

Table 24: Materials in contact with the sample gas

Subassembly	Component	Material
Gas paths	Gas connections	Thread connection: Stainless steel 1.4571
		Inlet/outlet fittings available: “Swagelok”: Stainless steel SS316 (≈ 1.4401) “PVDF: PVDF
	Internal gas lines	Hoses in fluorocarbon rubber “Viton” *or* Tubing in stainless steel 1.4571 [1]
	Safety filter	Glass
	Flame arresters [2]	Stainless steel 1.4404 (sintered metal “Siperm”)
UNOR/MULTOR cuvette	Cuvette tube	Stainless steel 1.4571 (140 and 200 mm long cuvettes: gold plated interior) *or* aluminum, gold plated interior
	Optical window	CaF_2 or BaF_2 or special version
	Glue	2-component special epoxy
	Sealing rings	Fluorocarbon rubber “Viton”
	Tube supports	Stainless steel 1.4571
OXOR-P measuring cell	Housing / Interior	Stainless steel 1.3952, SiO_2, platin-iridium; magnet poles gold-plated
	Glue	2-component epoxy glue
	Tube supports	Stainless steel 1.4301 (clamping rings: 1.4571)
OXOR-E (electrochemi-cal cell)	Enclosure	ABS
	Membrane	PTFE
	Internal seal	Fluorene rubber (acc. JIS B2401-4D)
	External seal	Fluorocarbon rubber “Viton”
	External T-piece	PP
THERMOR measuring cell	Enclosure	PVDF *or* stainless steel 1.4571
	Internal gas lines	Glass
Flow monitor / Condensate monitor [1]	Enclosure	Stainless steel 1.4571
	Sensors	Glass (coating of the PT100 resistors)
	Glue	2-component special epoxy
Pressure sensor [1]	T-piece	Stainless steel 1.4571
	Membrane	Bronze (CuZn) 2.1050
Gas pump [1]	Pump body	PVDF
	Membrane, valve seals	Fluorocarbon rubber “Viton”

[1] Option
[2] Only S720 Ex/S721 Ex.

19 Glossary

AC	Alternating Current
ATEX	ATEX: Atmosphères Explosifs: Abbreviation for European directives related to safety in potentially explosive atmospheres
CSA	Canadian Standards Association (www.csa.ca)
DC	Direct Current
Firmware	Internal device software; mainly stored in volatile memory (EEPROMs)
IP XY	International Protection (also: Ingress Protection); degree of protection of a device according to IEC/DIN EN 60529. The digit *X* designates protection against contact and impurities, *Y* protection against moisture.
LED	Light emitting diode (small indicator lamps)
NAMUR	Abbreviation for “Normen-Arbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie”, now “Interessengemeinschaft Automatisierungstechnik der Prozessindustrie” (www.namur.de)
NDIR	Non-dispersive infrared; Designation for optical gas analysis methods in infrared spectral range
Viton	DuPont Performance Elastomers trademark for materials made out of Fluorcarbon rubber

20 Index

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