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Process Gas Chromatographs
Process Gas Chromatographs

Introduction

Overview

Process gas chromatography is one of the most powerful measuring and analysis methods for process engineering. It is a procedure which is both discrete and extractive. This procedure is frequently used for online monitoring of processes since the sequences are easy to automate and a large number of components can be measured simultaneously.

Process gas chromatography can be used to separate and quantify the components of almost all homogenous gaseous or liquid mixtures. It must be possible to vaporize the liquid components without decomposition. The individual components of a discrete sample pass through the column system at different velocities, and are recorded in succession by a detector.

The time between sample introduction and registering of a substance at the detector (the retention time) is characteristic of the substance and is used to identify it. The magnitude of the detector signal is a measure of the volume concentration of the component in the gas or liquid.
Overview

The MAXUM edition II is a universal process gas chromatograph for flexible process applications with a wide variety of analytical possibilities. The MAXUM edition II combines various functional modules with a flexible oven concept and can therefore also optimally solve complex applications.

The MAXUM edition II is used in all sectors of the chemical industry, petrochemicals and refineries. It analyzes the chemical composition of gases and liquids in all production phases. The MAXUM edition II is suitable for installation in an analysis cabinet close to the process or in a close laboratory. Thanks to the flexible application possibilities, it can be used to analyze the initial material, the end product and also secondary products. The MAXUM edition II can also be used for many applications with environmental measurements.

The MAXUM edition II has extremely rugged and specially designed hardware and software. It automatically takes a sample from the process, and injects this onto the chromatographic columns.

With its powerful software and hardware, it satisfies the highest demands for measurement repeatability, and can be operated for a long time without manual interventions. Using powerful communications tools, the MAXUM edition II can send its results to process control systems. The comprehensive networking facilities can be applied to use several MAXUM edition II chromatographs together in large networks.

Benefits

MAXUM edition II with its combination of different analytical components offers a wide range of analytical possibilities. It is therefore possible to solve highly different measuring tasks with just one product. This reduces the costs for investment, training and stocking of spare parts.

The MAXUM edition II platform offers:

- Numerous oven configurations permit an optimum solution for almost every application
- Numerous types of detector and valve for the optimum analytical solution
- Intelligent electronics, local operation and central workstation for fast and simple operation, monitoring and maintenance
- Powerful software for best results
- Comprehensive I/Os and serial interfaces for internal and central interfacing
- Versatile networking possibilities for central maintenance and secure data transfer
- Many analytical possibilities as result of large application database
- Large and experienced support team provides global support

Hardware and software features

Simultaneous applications

Use one MAXUM edition II to provide the functionality of multiple GCs.

Parallel chromatography

Separate complex analytical tasks into simple parallel tasks and shorten analysis times.

Low operating costs

Flexible oven concept results in low consumption of air and energy.
Application

Chemical industry
- Monitoring of benzene in styrene in the ppb range
- Traces of residual gases in ultra-pure gases
- Determination of traces of hydrocarbons in air separation plants
- Fast analysis of CS₂ and H₂S in seconds
- Fast measurement of C6 to C8 aromatic compounds including the measurement of C9+ aromatics
- Monitoring of hydrogen in chlor-alkali plants
- Measurement of sulfurous components
- Measurement of C9 to C18 paraffins
- Determination of vinyl chloride in room air in a 60-second cycle
- Gas analysis during manufacture of vinyl chloride monomer (VCM)

Oil & gas
- Crack gas analysis
- Natural gas: Trace analysis for components such as mercaptans, H₂S or COS
- Fast determination of benzene in naphtha
- Determination of high boiling aromatics in a distillation fraction
- Fast measurement of acetylene in ethylene
- Total sulfur in petrol and diesel

Water/waste water
- Determination of halogenated hydrocarbons
- Simultaneous determination of chlorinated hydrocarbons, aromatics and alcohols in water
- Wastewater monitoring with PGC and stripper

Power engineering
- Power generation in coal-fired power plant.

Automotive industry
- Fast analytical measurement of methane in car exhausts
- High-speed chromatography for small molecules in propellants

Design

Chromatographic measuring equipment consists of a sampling system matched to the application, sample preparation with switchover to various sample streams if necessary, and the gas chromatograph with the analytical and electronic hardware as well as data processing, operation and communications software.

The MAXUM edition II gas chromatograph is divided into three sections depending on the version:
- The upper section contains the electronics with the power supply, controllers and analog electronics
- The middle section contains the pneumatics and some of the detectors (not with MAXUM edition II modular oven version)
- The bottom section contains the oven and the complete analytical components responsible for the separation

The MAXUM edition II is available prepared for wall mounting or for free mounting on a rack.

Extension of functionality

Network Access Unit (NAU)
- A MAXUM edition II without analytical section
- Available with or without HMI
- Has 7 slots for optional I/O plug-in cards
- Offers central MODBUS connection of several chromatographs to the control system

Function

Supply with carrier gas, combustion gas and auxiliary gases
A gas chromatograph must be supplied with carrier gas and, if applicable, combustion gas and other auxiliary gases depending on the analytical configuration. The carrier gas is used to transport the sample through the analytical system. Auxiliary gases are used to operate valves, as combustion gases for flame ionization detectors, and to purge the oven.

Injection system
The injection system is the link between the continuous process stream and the discrete analytical process. It is responsible for injecting an exactly defined portion of the sample in a reproducible and pulsed manner (as far as possible) into the carrier gas stream.

The injection can be carried out in the conventional manner using valves or by means of a live injection:
- Gaseous samples (0.1 to 5 ml)
- Completely vaporizable liquid samples (0.1 to 10 µl)

Gas injection valves

Model 50 10-port valve:
- Combined gas injection and backflushing valve
- Activation by pressure on the membrane without moving parts
- Can be used as gas injection valve or for column switching (6-port connection)
- > 3 million switching cycles without maintenance

Model 11 6-port valve:
- Can be used as gas injection valve, liquid injection valve or for column switching
- Membrane controlled by tappet
- One million switching cycles without maintenance
**Liquid injection valve FDV**

A constant quantity of a liquid sample can be automatically injected using the liquid injection valve, and subsequently vaporized rapidly and completely. The valve can also be used to inject small volumes of gas.

The liquid injection valve consists of three sections:
- Thermostatically-controlled vaporization system
- Sample passage section with seal
- Pneumatic drive

**Features:**
- Vaporization temperature 60 to 350 °C
- Injection volume 0.1 to 9.5 μl
- Sample temperature -20 to +150 °C
- Material of parts wetted by sample: Stainless steel, mat. no. 1.4571, Hastelloy, Monel or special materials
- Control pressure 400 to 600 hPa
- Max. sample pressure 6 000 kPa, recommended 50 to 100 kPa
- Connections for pipe: 3.14 mm (1/8") outer diameter

**Live injection add-on part**

Flexible selection of the injection volume which is exactly matched to the analytical tasks and the requirements of the columns is possible with the live injection add-on part.
Oven
A further important factor for the separating performance is the temperature. This has a very high influence on the vapor pressure of the individual components, and thus on the diffusion and the distribution equilibrium between the mobile and stationary phases in the column. This influences the retention times, and thus the identification of components. Therefore very high demands are placed on the temperature stability and repeatability of the oven and also on that of the injection equipment and the detectors.

Two different types of oven are available:

Airless oven for extremely stable isothermal oven temperatures (0.02 °C control accuracy) up to 80 °C (modular oven) or 280 °C depending on the version.

Airbath oven for
- isothermal (5 to 225 °C) or
- temperature-programmed mode

Both types of oven are available as
- single ovens or
- dual ovens.

With the dual ovens, two separate heating circuits provide independent oven temperatures. It is then possible to use two different temperatures for the respectively installed columns for one application or to carry out two or more applications in one chromatograph with different temperatures for the separation.

In order to measure sample components with highly different volatilities, a temperature program is frequently used for the chromatographic separation. In this case the column temperature is continuously increased according to a selectable heating-up rate. This method (PTGC) is available with the MAXUM edition II.

The internal oven consists of a chamber with low thermal capacity located within the standard oven. It contains the capillary column used for the separation.

The ovens have separate, independent temperature control. The temperature of the internal oven is freely-programmable. The temperature changes according to the time-dependent profile assigned to the respective analysis. Up to three linear ramps and four constant periods can be configured.

It is then possible to determine components with low and high boiling points in one analysis. Existing laboratory applications can be opened up by PTGC for use in the process industry.

"Simulated distillation" is an important application of PTGC in refineries. The distillation range - a quality criterion for fuels - is chromatographically traced "online".

Columns
The columns are the central component of the chromatograph. They resolve the gas mixture or the vaporized liquid into its individual components. The following distinction is made:

- Packed/micropacked columns with inner diameter of 0.75 to 3 mm
- Capillary columns with inner diameter of 0.15 to 0.53 mm

Packed columns are mechanically stable and simple to handle. Capillary columns have a significantly higher separating performance, often with a shorter analysis period and lower analysis temperature.

Types of column

- Packed columns
- Capillary columns
- Solid stationary phases
- Liquid stationary phases
- Internal diameter 0.75 ... 3 mm
- Internal diameter 0.15 ... 0.53 mm (narrow, normal and wide bore)
- narrow-bore 0.15 mm
- narrow-bore 0.32 mm
- wide-bore 0.53 mm
- Adsorptive change effect
- Distribution, solubility
Column switching systems

Process chromatographs are almost always equipped with column switching functions. Column switching is understood to be the combination of several columns in the carrier gas path which are arranged in succession or parallel. These columns usually have different separating performances, and are interconnected by valves for switching over the gas path.

A distinction is made between backflushing, cut and distribution. A wide range of techniques is available for column switching.

The techniques comprise highly stable membrane gas valves, membrane piston valves, sliding vane rotary valves and also valveless switching techniques.

Valves

Model 50 10-port valve:
- Combined gas injection and backflushing valve
- Activation by pressure on the membrane without moving parts
- Switches gas samples at an overpressure of 0 to 500 kPa
- Can be used as gas injection valve or for column switching (6-port connection)
- > 3 million switching cycles without maintenance

Model 11 6-port valve:
- Can be used as gas injection valve, liquid injection valve or for column switching
- Membrane controlled by tappet
- One million switching cycles without maintenance

Valveless switching technique

The valveless live column switching is exactly controlled by electronic pressure regulators, and prevents falsification of results since the sample does not come into contact with valves. A special pressure-controlled coupling element connects the capillary columns.

This technique is optimally suitable for capillary columns, and offers the best long-term stability and reliability. Live column switching is a technique where backflushing, cut or distribution is carried out on two different columns without any switching of valves or other moving components in the separation path.

This is achieved using a unique coupling unit, the live T-piece. Its function is based on pressure difference control regulated by the electronic precision pressure controllers of the MAXUM edition II. Because there is no dead volume whatsoever, it is ideally suitable for the low flow rates used with capillary columns. Maintenance of the column switching configuration is then superfluous, the separating performance is improved, and complicated separating procedures are simplified.
Live switching

Solenoid valve control module
- Contains all control elements in one module in order to reduce downtimes during repairs to a minimum
- Has 3-way and 4-way distributors for control of many different types of valve
- Uses separate, plug-on pipe connectors to permit implementation of variable gas supplies

Electronic pressure controller module (EPC)
- Permits exact control of pressure without mechanical pressure regulator. Shortens the setup time since the pressure is set by an operator input.
- Permits programmable pressure changes for fast chromatography and modern applications.
- Controls the supply of carrier gas and combustion gas. Avoids drift and deviations which can occur with mechanical pressure control.

Detectors
Thermal conductivity detectors (TCD) and flame ionization detectors (FID) are mainly used in process chromatography. Specific detectors such as flame photometer detector (FPD), electron capture detector (ECD), photo-ionization detector (PID), or helium ionization detector (HID) are used to a lesser extent.

The detector modules described above can be combined together in many different manners in the MAXUM edition II.
- A maximum of three detector modules can be used in the airbath oven.
- Up to three modules (depending on the type) can be used in the airless oven, the dual airless oven and the ovens with temperature programming.
- Thermal conductivity detectors (TCD) are used in the modular oven system.
- In the case of multiple modules such as the TCD, the measuring cells can be operated in parallel at offset times in order e.g. to increase the number of analyses within a specific time.
- Multiple modules can each be used with a column system for one sample stream. This shortens the total cycle time with multi-stream applications.
- Parallel use of two identical column systems provides redundant measurements which can be compared with each other, thus reducing the necessity for calibration.
<table>
<thead>
<tr>
<th>Detector</th>
<th>Measured value dependent on:</th>
<th>Selectivity</th>
<th>Application example</th>
</tr>
</thead>
<tbody>
<tr>
<td>WLD</td>
<td>Concentration</td>
<td>Universal</td>
<td>Main and subsidiary components</td>
</tr>
<tr>
<td>FID</td>
<td>Mass flow</td>
<td>Thermally ionizable components at &lt; 1 000 °C</td>
<td>Hydrocarbons</td>
</tr>
<tr>
<td>FPD</td>
<td>Mass flow</td>
<td>Substances containing S or P</td>
<td>Traces of sulfur in HC matrices</td>
</tr>
<tr>
<td>PDHID</td>
<td>Mass flow</td>
<td>Universal (except He and Ne)</td>
<td>Ultra-pure gas analysis</td>
</tr>
<tr>
<td>PDECD</td>
<td>Mass flow</td>
<td>Molecules with electronegative groups</td>
<td>Traces of halogenated hydrocarbons</td>
</tr>
<tr>
<td>PDPID</td>
<td>Mass flow</td>
<td>Selective, dependent on ionization potential</td>
<td>Traces of aromatic compounds, amines</td>
</tr>
</tbody>
</table>
Thermal conductivity detectors (TCD)
The measuring principle of the TCD is based on the difference between the thermal conductivity of a pure carrier gas stream and that of a gas mixture containing carrier gas and a component eluted from the column. Therefore all components whose thermal conductivity differs from that of the pure carrier gas can be detected by a TCD. TCDs always consist of one to three measuring cells and one or two reference cells which are electrically heated and contain wire resistors or thermistors connected in a Wheatstone bridge.

The amount of heat transferred to the cells is the same as long as pure carrier gas flows through the measuring and reference cells. The resistances are therefore also very similar, and the bridge resistors are balanced. If a mixture of carrier gas and sample component flows through the sample chamber, the change in thermal conductivity of the gas mixture also changes the amount of heat transferred and thus the temperature and resistance of the heating wires or thermistors in the sample chamber.

The resulting offset in the bridge circuit is directly proportional to the current concentration of the sample component in the carrier gas stream.

Versions of TCDs:
- Thermistor detector
- Filament detector

Both detectors are available for universal use, and the filament detector can also be used at higher temperatures. The thermistor detector is available as a block with 6 measuring detectors and two reference detectors. The filament detector has a measuring cell and a reference cell.

Flame ionization detector (FID)
With the flame ionization detector (FID), the gas leaving the column is burnt in a constantly burning hydrogen flame. If this gas mixture contains thermally ionizable components, e.g. flammable organic compounds, ions are generated when the compounds are burnt. These ions can transport charges which change (increase) the conductivity of the gas in the vicinity of the flame. In order to measure the conductivity or the number of ions, these can be collected at an electrode.

An electrode voltage is applied between the nozzle from which the flame burns and the electron collector positioned above it.

The resulting current is amplified, and is the measured signal.

In contrast to the TCD (concentration-dependent signal), the signal with the FID is proportional to the mass flow of the components.

The FID features a linear range of 6 to 7 powers of ten, and permits detection limits of less than 0.1 ppm (referring e.g. to the concentration of the hydrocarbon in the sample). Non-flammable components or those which only thermally ionize with difficulty (e.g. inert gases and water), or components which do not indicate thermal ionization at approx. 1 700 °C, cannot be measured with the FID.

In addition to the carrier gas, hydrogen and air are required as the flame gases to operate this detector.

Flame photometer detector (FPD)
Further detector principles are used for determination of trace concentrations of specific components. For example, the flame photometer detector is used to determine traces of compounds containing sulfur or phosphor. The emission of light of characteristic wavelengths is measured when burning the substances in a reducing hydrogen flame.

Pulsed discharge detector (PDD)
The detector can be used in three different versions: HID (helium ionization detector), ECD (electron capture detector) and PID (photo ionization detector). Installation in the Maxum GC is possible without further modification, and the detector can only be used in non-hazardous areas. The PDD uses stable, pulsed DC discharges in helium as the ionization source. The detector’s performance data is equal to or better than that of detectors which use radioactive ionization sources. Since a radioactive source is not used, the complex directives for radiation protection need not be observed by the customer.

- PDHD (helium ionization detector)
  The PDHD works almost destruction-free with an ionization rate of 0.01 to 0.1 %, and has a high sensitivity. The sensitivity for organic components is linear over five orders of magnitude, and the detection limit is in the low ppb range. The PDHD can be used universally for organic and inorganic components, with the exception of helium and neon.
- PDECD (electron capture detector)
  In electron capture mode, sample components with a high electron affinity can be selectively detected, such as halogenated hydrocarbons. The detector’s properties and sensitivity are comparable with those of a 63Ni ECD. It is necessary to use a supplementary gas in this mode (recommended: 3 % xenon in helium).
- PPPIP (photo ionization detector)
  A supplementary gas must also be used in this mode. Addition of 1-3 vol% of argon, krypton or xenon to the auxiliary gas leads to kinetic excitation of the added gas. The detector is used in this configuration for selective detection of aliphatic compounds, aromatic compounds and amines. The selectivity or energy level can be determined through the choice of added gas. The sensitivity in this mode is limited to sample components whose ionization potential is below the kinetic emission energy of the added gas.

Accessories: Catalytic air purifier
Instrument air is usually contaminated by traces of hydrocarbons. If this air is used as the combustion gas for a flame ionization detector (FID), the impurities are evident as disturbing background noise.

The catalytic air purifier eliminates interfering impurities of hydrocarbons in the combustion air for the FID detector. The products of the catalytic oxidation (H2O, CO2) have no influence on the detector. Use of the catalytic air purifier significantly reduces the background noise. It has a flameproof enclosure and is therefore explosion-proof.

The air within the purifier is passed through a spiral lined with palladium. This metal spiral is heated up to approx. 600 °C. Palladium has a high activity at this temperature, and almost complete catalytic oxidation is achieved despite the short dwell time. The air subsequently passes through a cooling loop, and is output purified and cooled.

Parallel chromatography
This function divides a complex application into several simple sub-applications which are analyzed in parallel. This reduces the cycle times.

The hardware and software of the MAXUM edition II allows a complex chromatographic analysis to be divided into several simple analyses. Each of these simple analyses can then be simultaneously executed in parallel. This not only simplifies the complete analysis, it can also be carried out faster and with greater reliability. In addition, maintenance of the simplified analyses is easier and faster.
**State-of-the-art communication**

TCP/IP communication and standard Ethernet hardware mean that MAXUM edition II is compatible with many networks.

**Software**

For simple operation and maintenance, MAXUM edition II offers an online software system with local operation over an HMI and a flexible GUI accessible using a computer workstation.

The online software system is installed in every MAXUM edition II or NAU and includes:
- Embedded EZChrom evaluation
- Embedded MaxBasic in the runtime version
- Communications software, network software, I/O driver in order to operate the gas chromatograph

The PC Workstation Software Gas Chromatograph Portal comprises:
- MAXUM edition II workstation tools:
- NetworkView to provide an overview of the network
- Method builder
- MMI maintenance panel emulator
- Data logger
- Modbus utility
- Backup and restore utilities
- Online system download utilities
- Online help and documentation

and optional packages for individual ordering, e.g.:
- MaxBasic editor
- Simulated distillation method
- OPC communications server

**Compatibility**

MAXUM edition II is compatible with all older types of chromatograph from Siemens: Advance Maxum.

**Application**

Certain parameters must be observed during application and subsequent operation of the MAXUM edition II. It can then be determined qualitatively whether the task is fulfilled. The basic prerequisite for this is that all components can be detected and clearly isolated from the interfering components. Important parameters are: Analysis period, measuring ranges, detection limits and repeatability of the results.
### Technical specifications

#### MAXUM edition II classic oven

**General**

- Smallest measuring ranges (depending on application):
  - Thermal conductivity: 0 ... 500 ppm
  - Flame ionization: 0 ... 1 ppm
- Temperature range in oven: Application-specific, depending on temperature class 5 ... 350 °C depending on oven version and temperature class
- Temperature control: ±0.02 °C
- EMI/RFI design:
  - CE-compatible; certified according to 2004/108/EC (EMC directive)
  - CE-compatible; certified according to 2006/95/EC (low-voltage directive)
  - Tested according to EN 61010-1 / IEC 1010-1

**Calibration**

- Type: Manual or automatic
- Zero value: Automatic baseline correction
- Span: Standard sample cylinder (single or multipoint calibration possible)

**Design, enclosure**

- Mounting:
  - Spacing on left: 460 mm from walls and other devices
  - Spacing on right: 460 mm in all cases
  - Spacing at front: 654 mm in all cases
  - Wall-mounted units
  - Center-to-center: 120 mm in all cases

**Weight**

- 77 kg

**Degree of protection**

- IP54, Category 2

**Danger class**

- Standard configurations:
  - Certified according to ATEX with air or nitrogen purging for Zones 1 and 2 (II2 Ex ... IIB + H2 ... Gb)
  - Suitable for use in non-hazardous areas and with non-dangerous conditions
  - Certified according to CSA C/US for use in Class 1, Div. 1, Groups B, C, D with air or nitrogen purging
  - Certified according to CSA C/US for use in Class 1, Div. 2, Groups B, C, D.

**Important note!**

Use in non-hazardous areas requires purging of the electronics area with air or nitrogen. PDD is not certified for hazardous areas.

### Configuration

**Oven options**

- Single isothermal oven or divided oven with two independent isothermal zones
- Single oven or two independent, airless ovens. The dual version has two separate oven areas with separate doors which operate completely independently.

**Detector modules for**

- Thermal conductivity, flame ionization, flame photometry, helium ionization, photo-ionization and electron capture

**Number of detector modules**

- 1, 2 or 3 in any combination of detector module types for airbath ovens
- 1 or 2 in any combination of detector module types for airless ovens, up to 3 in special configurations

**Sampling and column valves**

- Diaphragm valves, diaphragm piston valves, sliding vane rotary valves, slider valves, or liquid injection valve

**Valveless option**

- Live switching

**Columns**

- Packed, micropacked or capillary

**Regulation of gas supply**

- Up to 8 electronic pressure regulator channels and up to 6 mechanical pressure regulators

### Electrical characteristics

**Power supply**

- Single-phase AC, 100 ... 130 V or 195 ... 260 V (selectable), 47 ... 63 Hz
- Single oven: max. 14 A
- Dual oven: 2 circuits, max. 14 A each

**Gas inlet conditions**

- Sample flow: 5 ... 100 ml/min (depending on application)
- Sample filter size: 0.1 ... 5 µm with gaseous samples depending on type of valve
- Minimum sample pressure: 35 kPa, standard
- Maximum sample pressure: 200 kPa standard, higher pressure as option
- Maximum sample temperature: 121 °C standard; higher temperature as option
- Materials wetted by sample: Stainless steel and Teflon; other materials as option

**Liquid injection (valve)**

- Vaporization temperature: 60 ... 350 °C depending on application and temperature class
- Injection volume: 0.1 ... 9.5 µl
- Sample temperature: -20 ... +150 °C
- Material of parts wetted by sample: Stainless steel, mat. no. 1.4571, Hastelloy, Monel or special materials
- Control pressure: 400 ... 600 kPa
- Sample pressure: Max. 6 000 kPa, recommended 50 ... 100 kPa
- Connections for pipe: 3.14 mm (1/8”) outer diameter
### Measuring response

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity (depending on application)</td>
<td>± 0.5 % of span</td>
</tr>
<tr>
<td>Linearity (depending on application)</td>
<td>± 2 % of span</td>
</tr>
<tr>
<td>Effects of vibrations</td>
<td>Negligible</td>
</tr>
<tr>
<td>Repeatability in % of full span between</td>
<td>2 and 100 %: ± 0.5 %; 0.05 and 2 %: ± 1 %; 0.5% and 500 ppm: ± 2 %; 5 and 50 ppm: ± 3 %; 0.5 and 5 ppm: ± 5 %</td>
</tr>
<tr>
<td>Detection limits</td>
<td>See detectors</td>
</tr>
</tbody>
</table>

### Influencing variables

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects of ambient temperature</td>
<td>None with electronic pressure control</td>
</tr>
<tr>
<td></td>
<td>Different effects with mechanical pressure control (depending on application)</td>
</tr>
</tbody>
</table>

### Electrical inputs and outputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard input and output</td>
<td>• 2 analog outputs;</td>
</tr>
<tr>
<td></td>
<td>• 4 digital outputs (1 for output of system faults, 3 are user-configurable);</td>
</tr>
<tr>
<td></td>
<td>• 4 digital inputs;</td>
</tr>
<tr>
<td></td>
<td>• 3 serial outputs</td>
</tr>
<tr>
<td>Card slots for optional inputs and outputs via internal I2C bus</td>
<td>2</td>
</tr>
<tr>
<td>Input and output cards</td>
<td>A IO 8: 8 analog outputs, 8 analog inputs, 2 digital inputs</td>
</tr>
<tr>
<td></td>
<td>D IO: 6 digital inputs and 8 digital outputs</td>
</tr>
<tr>
<td></td>
<td>AD I/O: 4 digital inputs and 4 digital outputs, 4 analog inputs and 4 analog outputs</td>
</tr>
<tr>
<td>Digital inputs</td>
<td>Optocoupler with internal power supply (12 ... 24 V DC), switchable by dry contacts.</td>
</tr>
<tr>
<td></td>
<td>Alternative: switchable by external power supply 12 ... 24 V DC (only dry relay contacts), external power supply, negative connection linked to ground, for a specific digital input.</td>
</tr>
<tr>
<td>Digital outputs</td>
<td>Dry changeover contacts, max. contact rating: 1 A with 30 V DC.</td>
</tr>
<tr>
<td></td>
<td>Diode bypass suppression should be used for inductive loads.</td>
</tr>
<tr>
<td>Analog inputs</td>
<td>-20 ... +20 mA into 50 Ω or</td>
</tr>
<tr>
<td></td>
<td>-10 ... +10 V Rm = 0.1 MΩ, alternate insulation up to 100 V</td>
</tr>
<tr>
<td>Analog outputs</td>
<td>0/4 ... 20 mA into max. 750 Ω, common negative pole, electrically isolated from ground, freely-connectable to ground</td>
</tr>
<tr>
<td>Termination</td>
<td>Screw terminal for shielded or solid cable with a maximum area of 18 AWG or 0.82 mm²</td>
</tr>
</tbody>
</table>

### Climatic conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>-18 ... 50 °C</td>
</tr>
<tr>
<td>Gas supply</td>
<td>Instrument air</td>
</tr>
<tr>
<td></td>
<td>• At least 350 kPa for units with valves Model 11 or Valco</td>
</tr>
<tr>
<td></td>
<td>• At least 825 kPa for units with valves Model 50</td>
</tr>
<tr>
<td></td>
<td>• At least 175 kPa for airbath ovens; 85 l/min per oven</td>
</tr>
<tr>
<td></td>
<td>• No instrument air for fan-free ovens</td>
</tr>
<tr>
<td>Carrier gas</td>
<td>• Nitrogen or helium in compressed gas cylinder, purity 99.998 %, or hydrogen with a purity of 99.999 % (depending on application).</td>
</tr>
<tr>
<td></td>
<td>• Typical consumption quantity: 5 100 l/month per detector module</td>
</tr>
<tr>
<td>Combustion gas</td>
<td>• Hydrogen with a purity of 99.999 %</td>
</tr>
<tr>
<td></td>
<td>• Typical consumption quantity: 2 000 l/month per detector module</td>
</tr>
<tr>
<td>Combustion air</td>
<td>• Reference air (&lt; 1 ppm THC, O₂ concentration 20 ... 21 %). Supply through instrument air with catalytic purification (optional).</td>
</tr>
<tr>
<td></td>
<td>• Typical consumption quantity: 26 000 l/month</td>
</tr>
<tr>
<td>Corrosion protection</td>
<td>• Purging with dry air to protect the electronics</td>
</tr>
<tr>
<td></td>
<td>• Air bath oven with stainless steel lining</td>
</tr>
<tr>
<td></td>
<td>• Airless oven made of aluminum</td>
</tr>
<tr>
<td></td>
<td>• Steel lining painted on outside (epoxy powder coating)</td>
</tr>
</tbody>
</table>

### Communication

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial output</td>
<td>RS 232, RS 485, e.g. Modbus</td>
</tr>
<tr>
<td>Ethernet</td>
<td>Standard 10/100 BaseT Ethernet with 4 RJ 45 connectors</td>
</tr>
<tr>
<td></td>
<td>e.g. Modbus TCP IP or OPC</td>
</tr>
<tr>
<td></td>
<td>Optional ESBF board</td>
</tr>
<tr>
<td></td>
<td>Fiber-optic 100Base FX multimode with ST connection</td>
</tr>
<tr>
<td></td>
<td>3 x RJ45 and 1 x optical or Scalance network components e.g. for redundant connections.</td>
</tr>
</tbody>
</table>
### MAXUM edition II modular oven

#### General
- Smallest measuring ranges (depending on application): Only for gaseous sample, Thermal conductivity: 0 ... 500 ppm.
- Temperature range in oven: Application-specific, depending on temperature class 60 ... 80 °C depending on application temperature class T4.
- Temperature control: ± 0.02 °C.
- EMI/RFI design: CE-compatible; certified according to 2004/108/EC (EMC directive), CE-compatible; certified according to 2006/95/EC (low-voltage directive), Tested according to EN 61010-1 / IEC 1010-1.
- Calibration: Comparison measurement with external standard.
- Type: Manual or automatic.
- Zero value: Automatic baseline correction.
- Span: Standard sample cylinder (single or multipoint calibration possible).

#### Design, enclosure
- Spacing on left: 480 mm from walls and other devices.
- Spacing on right: 460 mm in all cases.
- Spacing at front: 654 mm in all cases.
- Wall-mounted units.
- Center-to-center: 1 120 mm in all cases.
- Wall-mounted units.
- Center-to-center: 1 120 mm in all cases.
- Mounting: Spacing on left: 480 mm from walls and other devices.
- Spacing on right: 460 mm in all cases.
- Spacing at front: 654 mm in all cases.
- Wall-mounted units.
- Center-to-center: 1 120 mm in all cases.
- Spacing on left: 480 mm from walls and other devices.
- Spacing on right: 460 mm in all cases.
- Spacing at front: 654 mm in all cases.
- Wall-mounted units.
- Center-to-center: 1 120 mm in all cases.
- Weight: 60 kg.
- Degree of protection: IP54, Category 1.
- Danger class: Standard configurations: Certified according to ATEX with air or nitrogen purging for Zones 1 and 2 (II2G Ex ... IICT 4 Gb).
- Suitable for use in non-hazardous areas and with non-dangerous conditions.
- Certified according to CSA C/US for use in Class 1, Div. 1, Groups B, C, D with air or nitrogen purging.
- Certified according to CSA C/US for use in Class 1, Div. 2, Groups B, C, D.
- Important note: Use in non-hazardous areas requires purging of the electronics area with air or nitrogen.

#### Configuration
- Oven options: Single oven or two independent, airless ovens. Optionally small oven for one small analytical module, large oven for two small analytical modules or one large analytical module. Two small ovens, two large ovens or any combination of 2 ovens is possible. Each dual oven version has two separate oven areas with separate doors which operate completely independently.
- Detector modules for: Thermal conductivity.
- Detectors: 1 4-cell TCD for small analytical modules and 1- or 2 4-cell TCD for large analytical modules.
- Sampling and column valves: Diaphragm valves Model 50 small analytical module with 1 x M50 large analytical module with 1, 2 or 3 x M50.
- Columns: Packed, micropacked or metal capillary columns.
- Regulation of gas supply: Up to 6 electronic pressure regulator channels and up to 4 mechanical pressure regulators.

#### Electrical characteristics
- Power supply: Single-phase AC, 85 ... 264 V, 47 ... 63 Hz.
- Max. 655 VA, nominal 280 VA.
- Optional: 24 V DC ± 10 % 10 A with 32 V voltage limiting.
- Max. 100 mV residual ripple and interferences minimum to maximum at 20 MHz.
- Fusing at max. 20 A.
- External 24 V supply must accept minus to ground.

#### Gas inlet conditions
- Sample flow: 5 ... 100 ml/min (depending on application).
- Sample filter size: 0.1 µm with gaseous samples.
- Minimum sample pressure: 35 kPa, standard.
- Maximum sample pressure: 200 kPa standard, higher pressure as option.
- Maximum sample temperature: 80 °C maximum.
- Materials wetted by sample: Stainless steel, aluminum, Viton, polyimide and Teflon.

#### Measuring response
- Sensitivity (depending on application): ± 0.5 % of span.
- Linearity (depending on application): ± 2 % of span.
- Effects of vibrations: Negligible.
- Repeatability in % of full span between 2 and 100 %: ± 0.5 %; 0.05 and 2 %: ± 1 %; 50 and 500 ppm: ± 2 %; 5 and 50 ppm: ± 3 %; 0.5 and 5 ppm: ± 5 %.
- Detection limits: See detectors.

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### Influencing variables

| Effects of ambient temperature | None with electronic pressure control  
|                              | Different effects with mechanical pressure control (depending on application) |

### Electrical inputs and outputs

| Standard input and output | 2 digital outputs (1 for output of system faults, 1 is user-configurable)  
|                          | 2 serial outputs, 1 x RS 232/RS 485, 1 x RS 485  
| Card slots for optional inputs and outputs via internal I2C bus | 2  
| Input and output cards | A I/O: 8 analog outputs, 8 analog inputs, 2 digital inputs  
|                        | D I/O: 6 digital inputs and 8 digital outputs  
|                        | AD I/O: 4 digital inputs and 4 digital outputs, 4 analog inputs and 4 analog outputs  
| Digital inputs | Optocoupler with internal power supply 24 V, switchable by dry contacts.  
|                | Alternative: switchable by external power supply 12 ... 24 V DC (only dry relay contacts), external power supply, negative connection linked to ground, for a specific digital input.  
| Digital outputs | Dry changeover contacts, max. contact rating:  
|                | 1 A with 30 V DC.  
|                | Diode bypass suppression should be used for inductive loads.  
| Analog inputs | -20 ... +20 mA into 50 Ω or  
|                | -10 ... +10 V R<sub>s</sub> = 0.1 MΩ, alternate insulation up to 100 V  
| Analog outputs | 0/4 ... 20 mA into max. 750 Ω, common negative pole, electrically isolated from ground; freely-connectable to ground  
| Termination | Screw terminal for shielded or solid cable with a maximum area of 18 AWG or 0.82 mm² |

### Climatic conditions

| Ambient temperature | -18 ... 50 °C  
|---------------------|-----------------  
| Instrument air | At least 825 kPa for units with valves Model 50  
|                   | No instrument air for fan-free ovens  
| Carrier gas | Nitrogen or helium in compressed gas cylinder, purity 99.998 %, or hydrogen with a purity of 99.999 % (depending on application).  
|               | Typical consumption quantity: 5 100 l/month per detector module  
| Corrosion protection | Purging with dry air to protect the electronics  
|                    | Air bath oven with stainless steel lining  
|                    | Airless oven made of aluminum  
|                    | Steel lining painted on outside (epoxy powder coating)  

### Gas supply

| Serial output | RS 232, RS 485, e.g. Modbus  
|               | Standard 10/100 BaseT Ethernet with 2 RJ 45 connectors e.g. Modbus TCP/IP or OPC  
|               | Optional ESBF board  
|               | Fiber-optic 100Base FX multimode with ST connection  
|               | 3 x RJ45 and 1 x optical or Scalance network components e.g. for redundant connections.  

| Ethernet | RS 323, RS 485, e.g. Modbus  
|          | Standard 10/100 BaseT Ethernet with 2 RJ 45 connectors e.g. Modbus TCP/IP or OPC  
|          | Optional ESBF board  
|          | Fiber-optic 100Base FX multimode with ST connection  
|          | 3 x RJ45 and 1 x optical or Scalance network components e.g. for redundant connections.  

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Selection and ordering data

Please contact your Siemens sales partner to order a device.

Dimensional drawings

Notes: Only for airbath oven:
- Left outlet for applications with one single oven
- Left and right outlets for applications with divided oven

MAXUM edition II, dimensions in mm
MAXUM edition II modular oven, dimensions in mm
Overview

The MicroSAM is a miniaturized process gas chromatograph (GC) in an Ex d enclosure. Through consistent use of micro-system technology (silicon wafer technology), all analytical components are concentrated in the smallest possible area. The design particularly enables a distributed installation close to the process.

Benefits

- The distributed field installation reduces investment costs, and opens up new fields of application, e.g.: - Installation in plant areas where mounting within an analyzer shed is not possible - Installation at remote locations without extended infrastructure
- Reduction in laboratory analyses through online measurements
- Low space requirements in analysis cabinets reduce investment costs
- Low maintenance effort and gas/energy consumption reduce operating costs
- High-resolution capillary columns permit fast analyses
- Live injection permits representative sample injections
- Maintenance-free, valveless separating column switching with electronic pressure controllers
- The use of several micro thermal conductivity detectors (multidetection) provides exact measuring results and also validation possibilities
- Versatile networking possibilities for central maintenance and secure data transfer
- Remote monitoring with Windows-based software and Ethernet communication
- Simplified servicing through replacement of modules

Application

Chemical industry

- Analysis of ethylene in 1.2-dichloroethane (EDC) for process control
- Fast determination of nitrogen in acetylene for process control
- Hydrocarbon analysis of starting product (LPG) of a cracker
- Safety measurement of ethylene oxide during unloading of tankers
- Multicomponent analysis in ethylene oxide
- Analysis of methanol, water and dimethylether in a pilot plant
- Monitoring of coolant: Trace monitoring in chloromethane
- Analysis of nitrogen and hydrogen in pure gas of a chlor-alkali plant

Oil & gas

- Hydrogen analysis in recycled gas and other process gases
- Analysis of inert gases and low-boiling paraffins/olefins in combustion gas
- Analysis of hydrogen and low-boiling hydrocarbons in reformer/platformer plant
- Trace analysis of impurities in acetylene from a cracker
- Analysis of ethane in ethylene from a cracker
- Measurement of calorific value in exhaust gas for quality control in a power plant
- Analysis of ethylene in methane in an ethylene plant
- Analysis of propadiene and propine in the C2 splitter of a steam cracker
- Analysis of low-boiling hydrocarbons in an ethylene plant/vibreaker
- Analysis of exhaust gas in flares
- Analysis of gas loop in a propylene oxide plant
- Analysis of CO in crack gas in an LDPE (low-density polyethylene) plant
- Analysis of refinery gas in a pilot plant
- Analysis of calorific value in natural gas preparation plants

Iron & steel

Analysis of exhaust gas in blast furnaces.

Pharmaceutical industry

- Analysis of O₂, N₂, CO₂ and water in fermenting processes
- Analysis of alcohols in nitrogen for vacuum drying plants

Metals, aggregates, cement

Analysis of mine gas for inert gases and hydrocarbons.
**Design**

**Enclosure**
- EEx d version standard
- Heating adjustable from 60 to 165 °C (isothermal)
- Decentralized installation close to sampling point

**Analytical module**
The compact analytical module contains all the functional components of a chromatograph. The MicroSAM works with:
- Live injection
- Valveless live switching on microchip basis
- Standardized analytical modules
- Multidetection through use of up to 8 micro thermal conductivity detectors (TCDs) in the smallest possible area (e.g. on all column/purging outputs and injection)

**Function**

**Live injection**
The MicroSAM has a two-stage injection system. Using a micro injection valve, a defined quantity of sample is first brought up to the carrier gas pressure. This eliminates the pressure-dependent error in the dosing quantity present with conventional systems. In the second stage, the sample is transferred to the column by a valveless micro injection system (live dosing). The result is an “active” injection.

The injection volume can be varied time-controlled, and exactly matched to the column requirements.

**Valveless live column switching**
Because of the high dead volume of conventional valves, only the valveless version can be considered for a miniaturized system. In this case, the generation of differences in flow using several electronic pressure regulators at appropriate positions of the column setup causes a change in the flow directions. (The system operates according to the Wheatstone principle, but pneumatically.) The functions “Cut” and “Backflushing” can then be implemented free of dead volume.

**The column system**
The column system consists of two or three capillary columns connected in sequence. Micro TCDs or micro live circuits are installed in sequence (“inline”) upstream and downstream of the individual columns. Three electronic pressure regulators supply the columns with carrier gas and carry out the switching functions (injection, backflushing and cut).

By using narrow-bore capillary columns, the separation at high resolution is carried out within a much shorter time, approx. factor 2 to 3 compared to standard capillary columns.

**Electronic pressure regulators**
A high pressure stability together with rapid changing rates in the hPa range are required for precise and fast switching. This is achieved in the electronic pressure regulators by means of a piezo actuator.

**Detector**
The micro TCDs (based on silicon wafer technology) work on the principle of continuous measurement of the different thermal conductivities of the carrier gas and the components to be measured.

The measurement can be carried out without falsification by avoiding catalytic effects on the heating wires and maintaining a constant flow velocity. This permits consistent in-line detection, i.e. without qualitative or quantitative losses of substances.

**Application modules**
The application modules contain live injection and live switching. The modules D06, D08 and D11 have one separating column less than the modules D01, D02 and D09. The modules D06, D08 and D11 have one detector less than the modules D01 and D02. The application modules are suitable for separation of the components described below. However, when defining the suitable application module for an actual, customer-specific measuring task, technical evaluation by our Support Team is required.

D01, D02 and D08:
These modules contain separating columns that can be impaired in their separating performance by humidity in the carrier gas. For this reason, a carrier gas dry filter (filter set: Article No. A5E00400116) is integrated for these modules on the support bracket of the MicroSAM or supplied as a separate part as standard.

The application modules are suitable for separation of the components described below.

<table>
<thead>
<tr>
<th>Detector</th>
<th>Column 1</th>
<th>Detector</th>
<th>Column 2</th>
<th>Detector</th>
<th>Circuit</th>
<th>Column 3</th>
<th>Detector</th>
</tr>
</thead>
<tbody>
<tr>
<td>D01</td>
<td>TCD</td>
<td>Sil5 C3, C4, C5, C6+</td>
<td>TCD</td>
<td>PoraPLOT/Porabond Q CO2, C2, H2S, H2O</td>
<td>TCD</td>
<td>Live</td>
<td>Molecular filter H2, (Ar+O2), N2, C1, CO</td>
</tr>
<tr>
<td>D02</td>
<td>Injection</td>
<td>TCD</td>
<td>Sil5 C5+</td>
<td>TCD</td>
<td>SilicaPLOT C2, C3, C4 (saturated, unsaturated), C5+</td>
<td>TCD</td>
<td>Live</td>
</tr>
<tr>
<td>D09</td>
<td>Injection</td>
<td>-</td>
<td>Sil5</td>
<td>TCD</td>
<td>Sil5</td>
<td>TCD</td>
<td>Live</td>
</tr>
</tbody>
</table>

Application modules D01, D02 and D09
**Process Gas Chromatographs**

**MicroSAM**

<table>
<thead>
<tr>
<th>Application modules D06, D08, and D11</th>
</tr>
</thead>
</table>

### Application

Various solution concepts are available:

- **Adjustment without** method development (on request)
  - Run-out ex factory
    - The application modules are standardized. The functionality of the MicroSAM is proven with a specified carrier gas, exact setting of the oven temperature and the carrier gas inlet pressures, and with a standard calibration gas.
    - The measured components and switching functions (live injection, backflushing, cut) are saved.
  - Commissioning on site
    - All application modules are standardized, i.e. the analytical hardware is defined and cannot be changed. The specific settings are carried out on site during commissioning.

- **Adjustment with** method development
  - Non-standardized applications require specific method development:
    - An optimum solution is elaborated on the basis of an existing specification and a selected calibration gas or with application of a customer sample.
### Technical specifications

#### Design, enclosure

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>15 kg</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP65 (NEMA 4X)</td>
</tr>
<tr>
<td>Mounting</td>
<td>Post, pipe or wall</td>
</tr>
<tr>
<td>Installation on</td>
<td>300 mm (12&quot;)</td>
</tr>
<tr>
<td>Distance from wall or</td>
<td>200 mm (8&quot;)</td>
</tr>
<tr>
<td>wall or next chromatograp</td>
<td></td>
</tr>
<tr>
<td>Explosion protection</td>
<td>ATEX and IEC Ex: II 2 G Ex d IIC T4 Gb</td>
</tr>
<tr>
<td></td>
<td>Class I, Zone 1, Group IIB + H2 T4</td>
</tr>
<tr>
<td></td>
<td>Class I, Div 1, Groups B, C, D T4</td>
</tr>
<tr>
<td>Support bracket</td>
<td>Mounting part, dimensions (D x H)</td>
</tr>
<tr>
<td></td>
<td>380 x 110 mm</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>146 x 110 mm</td>
</tr>
</tbody>
</table>

#### Electrical characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 V DC (18.5 ... 30.2 V)</td>
</tr>
<tr>
<td>Power consumption</td>
<td>18 W</td>
</tr>
<tr>
<td></td>
<td>60 W</td>
</tr>
<tr>
<td></td>
<td>IEC 61010 / DIN VDE 0411</td>
</tr>
<tr>
<td></td>
<td>According to IEC 60801/ DIN VDE 0843</td>
</tr>
<tr>
<td>EMC immunity</td>
<td>• Conducted interferences on AC supply lines</td>
</tr>
<tr>
<td></td>
<td>2 kV</td>
</tr>
<tr>
<td></td>
<td>1 kV</td>
</tr>
<tr>
<td></td>
<td>2 kV</td>
</tr>
<tr>
<td></td>
<td>• Conducted interferences on signal lines</td>
</tr>
<tr>
<td></td>
<td>1 kV</td>
</tr>
<tr>
<td></td>
<td>8 kV</td>
</tr>
<tr>
<td></td>
<td>10 V/m</td>
</tr>
<tr>
<td></td>
<td>According to CISPR 11 / EN 55011 / DIN VDE 0875 Limit class B</td>
</tr>
<tr>
<td></td>
<td>2.5 A</td>
</tr>
</tbody>
</table>

#### Gas inlet conditions

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible sample pressure</td>
<td>10 ... 60 kPa above atmosphere</td>
</tr>
<tr>
<td>Sample flow</td>
<td>20 ... 100 ml/min</td>
</tr>
<tr>
<td>Max. sample temperature</td>
<td>120°C</td>
</tr>
<tr>
<td>Solid components</td>
<td>&lt; 0.1 mm</td>
</tr>
</tbody>
</table>

#### Climatic conditions

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible ambient temperature</td>
<td>- 20 ... 50 °C (depending on oven temperature)</td>
</tr>
<tr>
<td>Permissible storage/transport temperature</td>
<td>- 30 ... 70 °C</td>
</tr>
<tr>
<td>Permissible relative humidity</td>
<td>Max. 90 %</td>
</tr>
</tbody>
</table>

#### Sample and injection

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample streams</td>
<td>3</td>
</tr>
<tr>
<td>Calibration sample streams</td>
<td>1</td>
</tr>
<tr>
<td>Phase</td>
<td>Gaseous</td>
</tr>
<tr>
<td>Material with which the sample comes into contact</td>
<td>Stainless steel, fused silica, polyimide</td>
</tr>
<tr>
<td>Injection</td>
<td>• Controller</td>
</tr>
<tr>
<td></td>
<td>• Injection volume adjustable using switching times</td>
</tr>
<tr>
<td></td>
<td>• Max. operating temperature</td>
</tr>
<tr>
<td>Oven</td>
<td>Possible</td>
</tr>
<tr>
<td>Number/type</td>
<td>1/isothermal</td>
</tr>
<tr>
<td>Purging with N₂</td>
<td>160 x 10 mm</td>
</tr>
<tr>
<td>Dimensions (DxH)</td>
<td>20 W</td>
</tr>
<tr>
<td>Heating capacity</td>
<td>60 ... 155 °C</td>
</tr>
<tr>
<td>Temperature range</td>
<td>± 0.1 K (60 ... 155 °C)</td>
</tr>
<tr>
<td>Temperature stability</td>
<td>± 3 K (60 ... 155 °C)</td>
</tr>
<tr>
<td>Temperature accuracy</td>
<td>Approx. 0.3 %</td>
</tr>
<tr>
<td>Heating-up period from 30 ... 100 °C</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>

#### Columns and gases

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column type</td>
<td>Capillary columns 0.15 ... 0.25 mm/ internal</td>
</tr>
<tr>
<td>Separating column switching</td>
<td>Multidimensional chromatography with backflushing and cut in live system</td>
</tr>
<tr>
<td>Multifunctional diaphragm valve</td>
<td>For injection and backflushing</td>
</tr>
<tr>
<td>Gas connections</td>
<td>Swagelok 1/8&quot;</td>
</tr>
<tr>
<td>Pressure regulators</td>
<td>Max. 4 single-channel electronic pressure regulators</td>
</tr>
<tr>
<td>Solenoid valves for control of diaphragm valve</td>
<td>2 NC contacts, 2 NO contacts</td>
</tr>
<tr>
<td>Carrier gas</td>
<td>H₂, N₂, He, Ar</td>
</tr>
<tr>
<td></td>
<td>&gt; 99.999 % (5.0)</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.1 µm</td>
</tr>
<tr>
<td>Degree of separation</td>
<td>10 ... 60 ml/min</td>
</tr>
<tr>
<td></td>
<td>500 ... 700 kPa (g)</td>
</tr>
<tr>
<td></td>
<td>600 kPa (g) recommended</td>
</tr>
<tr>
<td>Instrument air</td>
<td>Not required</td>
</tr>
</tbody>
</table>

**Important:**
A continuous carrier gas supply is required for error-free operation (frequent carrier gas failure has a negative effect on the life cycle of the detectors and the internal device pressure regulator). In addition, an external two-layer pressure regulator for the carrier gas pressure is strongly recommended.
### Process Gas Chromatographs

**MicroSAM**

<table>
<thead>
<tr>
<th>Detectors, calibration and performance data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Detector type</strong></td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
</tr>
<tr>
<td><strong>Vibrations</strong></td>
</tr>
<tr>
<td><strong>Cell volume</strong></td>
</tr>
<tr>
<td><strong>Calibration</strong></td>
</tr>
<tr>
<td><strong>Smallest measuring range</strong></td>
</tr>
<tr>
<td><strong>Linear range</strong></td>
</tr>
<tr>
<td><strong>Cycle time</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical inputs and outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic equipment</strong></td>
</tr>
<tr>
<td>• Digital outputs (relay contact 0.4 A / 24 V DC)</td>
</tr>
<tr>
<td>• Digital inputs (24 V to optocoupler)</td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
</tr>
<tr>
<td>• Communication</td>
</tr>
<tr>
<td>• Control system coupling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communication and analytical controller (CAC)</strong></td>
</tr>
<tr>
<td>• Microprocessor</td>
</tr>
<tr>
<td>• Flash EPROM</td>
</tr>
<tr>
<td>• Dynamic RAM</td>
</tr>
<tr>
<td>• Operating system</td>
</tr>
<tr>
<td><strong>Realtime signal processor (RSP)</strong></td>
</tr>
<tr>
<td>• Microprocessor</td>
</tr>
<tr>
<td>• Flash EPROM</td>
</tr>
<tr>
<td>• Static RAM</td>
</tr>
<tr>
<td>• Operating system</td>
</tr>
<tr>
<td><strong>Controller</strong></td>
</tr>
<tr>
<td>• Sample streams</td>
</tr>
<tr>
<td>• Calibration sample streams</td>
</tr>
<tr>
<td>• Status LEDs for</td>
</tr>
<tr>
<td>• LCD display for</td>
</tr>
<tr>
<td><strong>Recommended operator panel</strong></td>
</tr>
<tr>
<td>• Personal computer</td>
</tr>
<tr>
<td>• Processor</td>
</tr>
<tr>
<td>• Clock</td>
</tr>
<tr>
<td>• Interfaces</td>
</tr>
<tr>
<td>• Operating system</td>
</tr>
<tr>
<td>• Software</td>
</tr>
</tbody>
</table>
### Selection and ordering data

<table>
<thead>
<tr>
<th>Article No.</th>
<th>Selection and ordering data</th>
</tr>
</thead>
<tbody>
<tr>
<td>7KQ3101-00000</td>
<td>MicroSAM process gas chromatograph</td>
</tr>
</tbody>
</table>

- Basic unit, mounted on holding bracket
- For 3 sample streams + 1 calibration stream
- For ambient temperatures from -20 to 50 °C
- Explosion-proof, for Zone 1 and Class I Div.1
- Power supply 24 V DC
- For post, pipe or wall mounting

Click on the Article No. for the online configuration in the PIA Life Cycle Portal.

#### Sample
- For gaseous sample
- For gaseous sample (standard UKOG)

#### Workstation operating software
- (1 workstation operating software required per GC network)
- Without operating software
- With workstation operating software

### Additional versions

<table>
<thead>
<tr>
<th>Order code</th>
<th>Application modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Without operating software</td>
</tr>
<tr>
<td>B</td>
<td>With workstation operating software</td>
</tr>
</tbody>
</table>

Add "-Z" to Article No. and specify Order codes.

### Application modules

- See description at function of application modules

### Standard applications with defined hardware

- Method development in the application
- Standard
- Special application
- Acceptance and customer information
- (in agreement with application laboratory)
- Remote acceptance
- Factory acceptance, 1 day
- Factory acceptance, 2 days
- Factory acceptance, 3 days
- Repeatability test
- Standard (2 hours)
- Up to 8 hours
- Up to 24 hours
- Up to 72 hours
- Data transmission
- Modbus mapping (during commissioning)
- Inputs/outputs via I/O-Extender
- Separate supply of the I/O Extender module
- (without protective casing, not for hazardous areas)
- 4 digital inputs, 4 digital outputs, 2 analog inputs, 4 analog outputs
- Analog values via external unit (standard package 1): Zones 1 and 2
- Analog values via external unit (standard package 2): Zones 1 and 2
- 12 digital inputs, 12 digital outputs, 6 analog inputs, 12 analog outputs
- Analog values via external unit (standard package 3): Class I Div 2
- 4 digital inputs, 4 digital outputs, 2 analog inputs, 4 analog outputs
- Analog values via external unit (standard package 4): Class I Div 2
- 12 digital inputs, 12 digital outputs, 6 analog inputs, 12 analog outputs
- Miscellaneous calculations and functions
- using BASIC interpreter integrated in the GC
- MicroSAM Basic Editor
- Application setup: Calculations in accordance with ISO 6976-95
- Application setup: Natural gas - calculations in accordance with GPA 2172-96
- Application setup: Natural gas - calculations in accordance with GOST 22667-82
- Application setup: Natural gas - customer-specific calculations

1) On request
Support bracket
For easy mounting, incl. support for 8 gas connections consisting of:
- Mounting part: Dimensions: 380 mm x 110 mm (WxH)
- Bracket for gas connection:
  - dimensions 146 mm x 110 mm (DxH)
  - Bracket on right side, mounted at right angle
The bracket is stipulated in the manual.
Exception
The bracket is not required if the MicroSAM is fitted in a protective casing approved by Siemens. In this case, however, shipping of the unit is only permissible in this protective casing.

Sample streams
For up to 4 sample streams (including calibration stream); e.g. 3 sample streams + 1 calibration stream; controlled by 4 internal digital outputs (relay contact 0.4 A / 24 V DC)

Pos. 8_0: For gaseous sample
This position contains a basic unit prepared for integration of the analyzer modules.

Pos. 8_8: Standard UKOG
Individual customers standard.

Pos. 9_B: Workstation operating software
The workstation operating software can only be ordered together with MicroSAM. Workstation operating software is required for each gas chromatograph network.

C01 – Method development and application
Comprehensive and specific development of the method is required for the tasks. The measured components and switching functions are entered completely using a customer sample (or a specially selected calibration gas). Proof of repeatability is carried out in accordance with the customer specification.

If a natural gas analyzer for calculation of the calorific value is ordered, the evaluation parameters are specifically optimized for the natural gas analysis.

The required BASIC programs (H0X) are installed in the gas chromatograph.

The retention time window C6+ is set to the measured components n-C6 to C9.

J0X – Acceptance and customer information
The scope of delivery is checked and the documentation and operation of the device explained in detail during the factory acceptance.

This also comprises presentation of the analytical solution including communication, chromatograms, piping plan and gas path plan. If present, inspection of the sample preparation and discussion of the documentation are carried out.

Please supplement the order for J02 to J04 by the desired option from E0x.

Only experienced MicroSAM users should consider the option for starting up the MicroSAM in the context of remote acceptance, e.g. using a telephone conference (on request).

E0X – Repeatability test
Proof of repeatability over a period of 2 h is included as standard. Longer proof of repeatability for the unit can be ordered using the supplements E02 to E04.

F01 – Data transmission over Modbus
Implementation and testing of a Modbus table for Modbus communication (RS 232 / RS 485 RTU).

K0X – Inputs/outputs via I/O Extender
The MicroSAM basic unit provides four digital inputs and outputs. If more interfaces are required, these are provided by the I/O Extender. It should be noted, however, that the I/O Extender requires two device-internal digital inputs and outputs. The I/O Extender solution can generate up to 12 additional analog outputs for the chromatograph (further inputs and outputs on request). The latest generation of NESSI components for sample preparation can also be controlled. The max. cable length between MicroSAM (including master cable) and I/O-Extender must not exceed 20 m. A 24 V DC power supply is required for the I/O Extender. This must be provided separately, but can also be covered by the power supply of the MicroSAM.

Note:
If the delivery is to include a protective casing from the Set CV range, please refer to this category in Catalog AP 01. There you can find more information on the I/O Extender and its specification within this total solution.

K02 or K04 standard packets 1/3
This position includes:
- Mounting rail
- An I/O Extender module
- Protective casing, Ex e with standard cable glands and terminal block; 170 x 227 x 131 mm (L x W x D)

The delivery package of the I/O Extender solution for Class I Div 2 contains adapters (female thread 1", 3/4", 1/2" for fitting of conduits) which are suitable for cable glands in accordance with this hazardous area.

K03 or K05 standard packets 2/4
This position includes:
- Mounting rail
- Three I/O Extender modules
- Protective casing, Ex e with standard cable glands and terminal block; 340 x 170 x 131 mm (L x W x D)

The delivery package of the I/O Extender solution for Class I Div 2 contains adapters (female thread 1", 3/4", 1/2" for fitting of conduits) which are suitable for cable glands in accordance with this hazardous area.

H0X - Various calculations and functions using BASIC interpreter integrated in the GC
The BASIC programs are either preset ex-works or can be created and modified by the customer.

H01 – MicroSAM BASIC Editor
The MicroSAM BASIC Editor allows individual programming of calculations and functions by the user.
**H02 - Application setup: Natural gas - calculation in accordance with ISO 6976-95**

The following physical variables must be calculated in accordance with the standard: calorific value, heating value, Wobbe index, density, relative density.

The calorific value is calculated as standard in MJ/m³ on a molar basis referred to the reference temperature 25 / 0 °C (combustion/metering temperature). Calculation on the basis of other reference variables or tables (in accordance with the standard) requires unambiguous specification by the customer.

The BASIC program is preset ex works; a customer modification is only possible with the supplement H01.

**H03 - Application setup: Natural gas - calculation in accordance with GPA2172-96**

The following physical variables must be calculated in accordance with the standard: calorific value, relative density and compressibility factor.

The calorific value is calculated as standard in BTU/ft³ (S) referred to the reference temperature 60 °F. Calculation on the basis of other reference variables or tables (in accordance with the standard) requires unambiguous specification by the customer.

The BASIC program is preset ex works; a customer modification is only possible with the supplement H01.

**H04 - Application setup: Natural gas - calculation in accordance with GOST22667-82**

The following physical variables must be calculated in accordance with the standard: calorific value, heating value, Wobbe index, relative density.

These parameters are calculated based on the physical properties of the pure components. As a special feature, the methane concentration is defined as the residual value in this operating mode.

The BASIC program is preset ex works; a customer modification is only possible with the supplement H01.

**H05 - Application setup: Customer-specific calculations and functions**

An unambiguous description of the task is required in order to guarantee correct functioning of the program.

The BASIC program is preset ex works; a customer modification is only possible with the supplement H01.

The supplement H03 is only possible together with C0X.

---

### Standard calibration gases for system test and run-out

<table>
<thead>
<tr>
<th>Calibration gas I in vol.%</th>
<th>Calibration gas II in vol.%</th>
<th>Calibration gas III in vol.%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2-butadiene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>1.3-butadiene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>1-butene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2,2 dimethylpropane</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>cis-2-butene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Cyclopropane</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Ethane</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Ethene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Ethine</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Ethyl acetylene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Helium</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Isobutane</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Isopentane</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Isopentane</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Methane</td>
<td>Approx. 85</td>
<td>Approx. 84.5</td>
</tr>
<tr>
<td>Methyl acetylene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>n-butane</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>n-heptane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>n-hexane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>n-pentane</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Propadiene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Propane</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Propene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>trans-2-butene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Vinyl acetylene</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>0.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

---

Box with I/O Extender
MicroSAM, dimensions in mm
Analysis of calorific value in natural gas preparation plants

Determination of calorific value in natural gas for power plants,

Analysis of natural gas in liquefaction and regasification plants

Analysis of bio-natural gas in preprocessing plants

Analysis of natural gas when opening up sea beds

Application switch and in-line detection.

Like the MicroSAM, the unit's high analytical capability can be attributed to narrow-bore capillary columns, live injection, live switching and in-line detection.

Flexible installation: The rugged and compact design enables installation in even extreme areas of application, such as offshore exploration, or directly at the pipeline. The SITRANS CV has the certification required (such as explosion protection or splashwater protection) to meet the requirements of these applications.

Notable features of the CVControl software, which has been specially developed for calibration-related applications, includes its ease of operation and transparency.

The serial RS 485/RS 232 and Ethernet interfaces enable communication with both the control system and a flow computer.

Like the MicroSAM, the unit's high analytical capability can be attributed to narrow-bore capillary columns, live injection, live switching and in-line detection.

Overview

The SITRANS CV gas chromatograph (GC), which is based on the innovative analytical technology of the MicroSAM, is an analyzer that has been specially developed for natural gas analysis. The device concept enables the higher and lower calorific value, standard density and Wobbe index (according to ISO, AGA 8, Gost standard) to be determined in a way that is not only cost-effective, but also quick, precise and reliable.

Benefits

The SITRANS CV gas chromatograph (GC), which is based on the innovative analytical technology of the MicroSAM, is an analyzer that has been specially developed for natural gas analysis. The device concept enables the higher and lower calorific value, standard density and Wobbe index (according to ISO, AGA 8, Gost standard) to be determined in a way that is not only cost-effective, but also quick, precise and reliable.

Function

Live injection

The SITRANS CV has a two-stage injection system. Using a micro injection valve, a defined quantity of sample is first brought up to the carrier gas pressure. This eliminates the pressure-dependent error in the dosing quantity present with conventional systems. In the second stage, the sample is transferred to the column by a valveless micro injection system (live dosing). The result is an “active” injection.

The injection volume can be varied time-controlled, and exactly matched to the column requirements.

Valveless live column switching

Because of the high dead volume of conventional valves, only the valveless version can be considered for a miniaturized system. In this case, the generation of differences in flow using several electronic pressure regulators at appropriate positions of the column setup causes a change in the flow directions. (The system operates according to the Wheatstone principle, but pneumatically.) The functions “Cut” and “Backflushing” can then be implemented free of dead volume.

The column system

The separation system consists of up to three separation columns connected in series. Micro TCDs or micro live circuits are installed in sequence (“inline”) upstream and downstream of the individual columns. Three electronic pressure regulators supply the columns with carrier gas and carry out the switching functions (injection, backflushing and cut).

By using narrow-bore capillary columns, the separation at high resolution is carried out within a much shorter time, approx. factor 2 to 3 compared to standard capillary columns.

Electronic pressure regulators

A high pressure stability together with rapid changing rates in the hPa range are required for precise and fast switching. This is achieved in the electronic pressure regulators by means of a piezo actuator.

Detector

The micro TCDs (silicon wafer technology) work on the principle of continuous measurement of the different thermal conductivities of the carrier gas and the components to be measured.

The measurement can be carried out without falsification by avoiding catalytic effects on the heating wires and maintaining a constant flow velocity. This permits consistent in-line detection, i.e. without qualitative or quantitative losses of substances.

Design

Enclosure

- EEx-d version standard
- Heating adjustable from 60 to 165 °C (isothermal)
- Decentralized installation close to sampling point

Analytical modules

The compact analytical modules contain all the functional components of a chromatograph. The SITRANS CV operates with:

- Live injection
- Valveless live switching on microchip basis
- Standardized analytical modules
- Multidetection through use of up to 8 micro thermal conductivity detectors in smallest possible areas (e.g. on all column/purging outputs and injection)

Application

- Analysis of natural gas in power plants:
  - For quality control
  - For turbine optimization
  - Pipeline monitoring
- Analysis of natural gas when opening up sea beds (off-shore plants).
- Analysis of bio-natural gas in preprocessing plants
- Analysis of natural gas in liquefaction and regasification plants (LNG Regasification and Storage)
- Determination of calorific value in natural gas for power plants, in gas transfer stations, or during turbine optimization
- Analysis of calorific value in natural gas preparation plants

Analytical modules

- Multidetection through use of up to 8 micro thermal conductivity detectors in smallest possible areas (e.g. on all column/purging outputs and injection)
Modèles

Les modules d’application standardisés généralement comportent des fonctions d’injection et de mise en service en direct, des détecteurs et des colonnes de séparation.

Application

Le SITRANS CV est un produit de stockage. La précalibration est effectuée à l’usine, en utilisant l’azote et l’argon (comme gaz porteur) et un gaz de calibrage. Les composants mesurés et les fonctions de mise en service (injection en direct, flush arrière, coupure) sont enregistrés dans la GC. Le processus de calibrage devrait être effectué lors de la mise en service sur site.

Les mesures peuvent être effectuées dans les intervalles de travail suivants :

<table>
<thead>
<tr>
<th>Tableau 1: Composants mesurés et paramètres de performance pour Pos. 8_0 (setup principal, analyse calorifique standard en conformité avec ISO 6976-1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composant</td>
</tr>
<tr>
<td>Methane</td>
</tr>
<tr>
<td>Nitrogen&lt;sup&gt;1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>Ethane</td>
</tr>
<tr>
<td>Propane</td>
</tr>
<tr>
<td>i-butane</td>
</tr>
<tr>
<td>n-butane</td>
</tr>
<tr>
<td>Neopentane</td>
</tr>
<tr>
<td>i-pentane</td>
</tr>
<tr>
<td>n-pentane</td>
</tr>
<tr>
<td>Hexane&lt;sup&gt;2)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Hexane</td>
</tr>
<tr>
<td>Heptane&lt;sup&gt;3)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Octane</td>
</tr>
<tr>
<td>Nonane&lt;sup&gt;4)&lt;/sup&gt;</td>
</tr>
<tr>
<td>H₂S</td>
</tr>
<tr>
<td>High/low calorific value</td>
</tr>
<tr>
<td>Density and relative density</td>
</tr>
<tr>
<td>Wobbe index</td>
</tr>
<tr>
<td>Compressibility factor</td>
</tr>
<tr>
<td>Normalisation factor</td>
</tr>
</tbody>
</table>

Tableau 2: Mesure de la composante supplémentaire oxygène de l’analyse calorifique étendue (voir Article No. 7KQ3105-1)<sup>*</sup>

La marque de note 1 sur la détection de l’oxygène et de l’azote n’est pas valable dans le cas d’une analyse calorifique étendue. Dans ce cas, tous les composants de la Table 1 “Composants mesurés et paramètres de performance pour Pos. 8_0 (setup principal, analyse calorifique standard en conformité avec ISO 6976-1995)” plus oxygène sont détectés et quantifiés.

Pour l’analyse de biométhane les suivants composants et leurs intervalles de travail sont mesurés (Tableau 3).

Tableau 3: Composants mesurés, intervalles de travail et gaz de calibrage pour l’analyse de biométhane

<table>
<thead>
<tr>
<th>Composant</th>
<th>Vaste possible (%)</th>
<th>Gaz de calibrage pour biométhane (%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>&gt; 80</td>
<td>89</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>&lt; 8</td>
<td>4</td>
</tr>
<tr>
<td>Ethane</td>
<td>&lt; 6</td>
<td>2.5</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>&lt; 4</td>
<td>2.5</td>
</tr>
<tr>
<td>Propane</td>
<td>&lt; 5</td>
<td>1.0</td>
</tr>
<tr>
<td>Butane</td>
<td>&lt; 1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Oxygen</td>
<td>&lt; 3</td>
<td>0.2</td>
</tr>
<tr>
<td>2-Methyl/propane</td>
<td>&lt; 0.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>&lt; 3</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Tableau 1: Composants mesurés et paramètres de performance pour Pos. 8_0 (setup principal, analyse calorifique standard en accord avec ISO 6976-1995)

1) Tout oxygène ou monoxyde de carbone présent dans la composition sera détecté à l’azote et, donc, le rapport de dilution est déterminé.
2) Hexane<sup>+</sup> = group<sub>(iso-hexane to iso-nonane)</sub>
3) Heptane<sup>+</sup> = group<sub>(iso-hexane) and group<sub>(iso-heptane to iso-nonane)</sub>
4) Nonane<sup>+</sup> = group<sub>(iso-hexane)-group<sub>(iso-heptane); group<sub>(iso-octane)-group<sub>(iso-nonane)</sub>

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For analysis of natural gas with backflush summation, the following components and working ranges are measured:

<table>
<thead>
<tr>
<th>Component</th>
<th>Possible working range (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>50 ... 100</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0 ... 25</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0 ... 20</td>
</tr>
<tr>
<td>Ethane</td>
<td>0 ... 20</td>
</tr>
<tr>
<td>Propane</td>
<td>0 ... 15</td>
</tr>
<tr>
<td>i-butane</td>
<td>0 ... 10</td>
</tr>
<tr>
<td>n-butane</td>
<td>0 ... 10</td>
</tr>
<tr>
<td>Neopentane*</td>
<td></td>
</tr>
<tr>
<td>i-pentane</td>
<td>0 ... 1</td>
</tr>
<tr>
<td>n-pentane</td>
<td>0 ... 1</td>
</tr>
<tr>
<td>Hexane+</td>
<td>0 ... 3</td>
</tr>
<tr>
<td>Helium</td>
<td>Concentration can be entered as a fixed value in the component list</td>
</tr>
<tr>
<td>H₂S</td>
<td>No measured component</td>
</tr>
</tbody>
</table>

Table 4: Component and measuring ranges for the analysis, including backflush summation

* Because the neopentane concentration is very small in practice, this component is not calibrated and is measured with the relative response factor of isopentane. For this reason, a possible working range is not indicated.

Analyses within the checked working range as well as the quality parameters resulting from these (upper and lower calorific values, density and relative density, Wobbe index, compression and normalization factors) correspond to the requirements listed below.

Measurements within the scope of the possible working ranges (Table 1 "Measured components and performance parameters for Pos. 8_0 (Master setup, standard analysis of calorific value in accordance with ISO 6976-1995)", right column, and Table 2 "Measuring range of the additional measured component oxygen of the extended analysis of calorific value (see Article No. 7KQ3105-1)") are possible. However, checking of the repeatability and correctness has not been carried out by the official German body "Physikalisch technischer Bundesanstalt (PTB)."

<table>
<thead>
<tr>
<th>Concentration range (mol.%)</th>
<th>Repeatability according to ISO 6974-5 (2001); Mol fraction (%), absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 &lt; xᵢ &lt; 100</td>
<td>0.03 ... 0.035</td>
</tr>
<tr>
<td>1 &lt; xᵢ &lt; 50</td>
<td>0.011 ... 0.03</td>
</tr>
<tr>
<td>0.1 &lt; xᵢ &lt; 1</td>
<td>0.006 ... 0.011</td>
</tr>
<tr>
<td>xᵢ &lt; 0.1</td>
<td>&lt; 0.006</td>
</tr>
</tbody>
</table>

Table 5: The repeatability of the measured components complies with ISO 6974-5 (2001) – Annex B (Article No. 7KQ3105-0, 7KQ3105-1)

The repeatability of the calorific value and standard density achieve a relative standard deviation of < 0.01 %. SITRANS CV for the analysis of biomethane achieves a relative standard deviation of < 0.05 %.

The calibration gas is an extremely important factor for consideration in terms of the MPE (maximum permissible error), and has a significant effect on the accuracy of the overall measuring system. For this reason, SITRANS CV - based on a comparative measuring procedure - can never be more accurate than the calibration gas used. Other parameters besides the accuracy data on the calibration gas certificate are important for the accuracy of a system. Examples of these include the optimum gas composition, the ambient temperatures of the calibration gas cylinders during transportation and operation, potential condensation of, for instance, higher hydrocarbons in a calibration gas cylinder, and the functionality of the sample preparation system.

Under optimum conditions, the SITRANS CV achieves an MPE of < 0.1 % for the calorific value and the standard density, whereby the system for measuring biomethane produces an MPE of < 0.5 %.

SITRANS CV is designed for measuring with various configurations; the calibration gases required for this purpose are shown below. (Table 6, Measurement and calibration gas components):
## SITRANS CV – Overview of possible configurations and the required calibration gases

<table>
<thead>
<tr>
<th>Carrier gas</th>
<th>He</th>
<th>He</th>
<th>Ar</th>
<th>He</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzer module</td>
<td>C09</td>
<td>C01</td>
<td>C01</td>
<td>C13</td>
</tr>
<tr>
<td>Calorific value analysis</td>
<td>C6+</td>
<td>C6+ with oxygen</td>
<td>Basic Bio-CH₄</td>
<td>Extended calorific value analysis Bio-CH₄</td>
</tr>
<tr>
<td>C6+ backflush</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calculation standard is ISO 6976, GOST and AGA 8 can be selected

### Article No.

<table>
<thead>
<tr>
<th>7KQ 3105-0</th>
<th>7KQ 3105-1</th>
<th>7KQ 3105-2</th>
<th>7KQ 3105-3</th>
</tr>
</thead>
</table>

| Hydrogen | - | - | M CR | - |
| Oxygen | M CR | M CR | M CR | M CR |
| Nitrogen | M CR | M CR | M CR | M CR |
| Carbon dioxide | M CR | M CR | M CR | M CR |
| Methane | M CR | M CR | M CR | M CR |
| Ethane | M CR | M CR | - | M CR |
| Propane | M CR | M CR | - | M CR |
| Isobutane | M CR | M CR | - | M CR |
| Butane | M CR | M CR | - | M CR |
| Neopentane | M*1 | M*1 | - | M*1 |
| Isopentane | M CR | M CR | - | M CR |
| Pentane | M CR | M CR | - | M CR |
| Group C6+ | M*2 CR | M*2 CR | - | M*2 CR |
| Group C6+ backflush | - | - | - | M*2 CR |

Extended application 7KQ 3105- B02

Separate measurement of Group C6 and Group C7+ | M*3 CR*3 | M*3 CR*3 | - | - |

Separate Groups C6, C7, C8, C9 | M*4 CR*4 | M*4 CR*4 | - | - |

### Caution!

Use of the SITRANS CV with a carrier gas different to that of the supplied solution can lead to faults and to the destruction of the analysis module. Depending on the composition of the calibration gas, external heating for the calibration gas cylinder may be necessary.

- **M** Measured
- **CR** Required as calibration component; composition see catalog AP 01 – SITRANS CV - Function
- **M*1** Neopentane is measured with the response factor of isopentane; for direct calibration of neopentane: see operating instructions
- **M*2** Group C6+ is measured with the relative response factor of n-hexane
- **M*3 CR*3** Groups C6 and C7+ are measured separately and calibrated with n-hexane and n-heptane, respectively
- **M*4 CR*4** Group C6, Group C7, Group C8, Group C9 are measured and calibrated separately

Table 6: Overview of device versions and available measurement configurations and the calibration gas compositions required for them
## Technical specifications

### Climatic conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible ambient temperature</td>
<td>-20 ... +55 °C (depending on oven temperature)</td>
</tr>
<tr>
<td>Permissible storage/transport temperature</td>
<td>-30 ... +70 °C</td>
</tr>
<tr>
<td>Permissible relative humidity</td>
<td>Max. 90 %</td>
</tr>
<tr>
<td>Protection against dust and moisture</td>
<td>IP 65</td>
</tr>
<tr>
<td>• According to EN 60529/IEC 60529</td>
<td>NEMA 4X</td>
</tr>
<tr>
<td>Power supply</td>
<td></td>
</tr>
<tr>
<td>Power supply</td>
<td>24 V DC (18.5 ... 30.2 V)</td>
</tr>
<tr>
<td>External fuse</td>
<td>T2.5 A</td>
</tr>
<tr>
<td>Power consumption, typical</td>
<td>18 W</td>
</tr>
<tr>
<td>Power consumption, maximum</td>
<td>60 W</td>
</tr>
</tbody>
</table>

### Dimensions and weights

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width x depth x height</td>
<td>360 x 300 x 220 mm</td>
</tr>
<tr>
<td>(approx. 14” x 12” x 9”)</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>15 kg (35 lb.)</td>
</tr>
</tbody>
</table>

### Mounting

<table>
<thead>
<tr>
<th>Mounting Details</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation on</td>
<td></td>
</tr>
<tr>
<td>Post, pipe or wall</td>
<td>300 mm (12”)</td>
</tr>
<tr>
<td>Distance from wall or next chromatograph</td>
<td></td>
</tr>
<tr>
<td>Distance from ceiling or floor</td>
<td>200 mm (8”)</td>
</tr>
</tbody>
</table>

### Electromagnetic compatibility

<table>
<thead>
<tr>
<th>Interference Type</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conducted interferences on AC supply lines</td>
<td></td>
</tr>
<tr>
<td>• According to Part 4 (burst)</td>
<td>2 kV</td>
</tr>
<tr>
<td>• According to Part 5 (ms pulses), line against line</td>
<td>1 kV</td>
</tr>
<tr>
<td>• According to Part 5 (ms pulses), line against ground</td>
<td>2 kV</td>
</tr>
<tr>
<td>Conducted interferences on signal lines</td>
<td></td>
</tr>
<tr>
<td>• According to Part 4 (burst)</td>
<td>1 kV</td>
</tr>
<tr>
<td>Immunity to static discharge</td>
<td>8 kV</td>
</tr>
<tr>
<td>• According to Part 2 (ESD)</td>
<td></td>
</tr>
<tr>
<td>Immunity to fields</td>
<td>10 V/m</td>
</tr>
<tr>
<td>• According to Part 3 and Part 6</td>
<td></td>
</tr>
</tbody>
</table>

### Safety

<table>
<thead>
<tr>
<th>Safety Type</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical safety</td>
<td>IEC 61010 / DIN VDE 0411</td>
</tr>
<tr>
<td>Explosion protection</td>
<td>ATEX and IEC Ex: II 2 G Ex d IIC T4 Gb Class I, Zone 1, Group IIB + H2 T4 Class I, Div 1, Groups B, C, D T4 Factory Sealed</td>
</tr>
</tbody>
</table>

### Oven

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number/type</td>
<td>1 / isothermal</td>
</tr>
<tr>
<td>Purging with N₂</td>
<td>Possible</td>
</tr>
<tr>
<td>Dimensions (D x H)</td>
<td>160 x 10 mm</td>
</tr>
<tr>
<td>Max. heating power</td>
<td>35 VA</td>
</tr>
<tr>
<td>Temperature range</td>
<td>60 ... 165 °C</td>
</tr>
<tr>
<td>Temperature stability</td>
<td>± 0.1 K (60 ... 165 °C)</td>
</tr>
<tr>
<td>Temperature accuracy</td>
<td>± 3 K (60 ... 165 °C)</td>
</tr>
<tr>
<td>Retention time variations per 10 °C change in ambient temperature</td>
<td>Approx. 0.3 %</td>
</tr>
<tr>
<td>Warm-up period from 30 … 100 °C</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>
Process Gas Chromatographs  
SITRANS CV

Columns and gases
Separating column switching
Multidimensional chromatography with backflushing and cut in live system
For injection and backflushing
Multifunctional diaphragm valve
Swagelok 1/8"
Gas connections
Max. 4 single-channel electronic pressure regulators
Pressure regulators
2 NC contacts, 2 NO contacts
Solenoid valves for control of diaphragm valve
Carrier gas
He, Ar

Notice:
The carrier gas defined for the delivered state must be used.
Changing the carrier gas could destroy the thermal conductivity detectors.
• Gas purity (minimum requirement) ≥ 99.999 % (5.0)
• Solid components < 0.1 μm
• Required filtration Degree of separation 99.99 % for 0.1 μm particles
• Consumption < 35 ml/min
• Inlet pressure 500 ... 700 kPa

Instrument air

Sample and injection
Sample streams
3
Calibration sample streams
1
Phase
Gaseous
Permissible sample pressure
10 ... 60 kPa above atmospheric pressure
Sample flow
20 ... 100 ml/min
Max. sample temperature 120 °C
Solid components
< 0.1 μm
Required filtration
Degree of separation 99.99 % for 0.1 μm particles
Material with which the sample comes into contact Stainless steel, fused silica, polyimide
Injection
“Valveless” live injection With multifunctional diaphragm valve
Injection volume adjustable using switching times From 2 ... 50 μl

Detectors, calibration and performance data
Detector type TCD, max. 8 sensors
Cell volume 0.02 μl
Calibration Manual or automatic, single level
Repeatability for calorific value and density ≤ 0.01 % (for natural gas)
Accuracy for calorific value and density ≤ 0.1 % (for natural gas)
Linear range Typically ≥ 10^4
Cycle time Application-dependent
Ambient temperature influence Negligible
Mean Time to Repair/MTBF < 1 hour / 3 years (without consumables)

Electronics: Communication and analytical controller (CAC)
Microprocessor Intel 586 architecture
Flash EPROM 128 MB
Dynamic RAM 64 MB
Operating system Windows CE 5.0
Software Preinstalled. Modifications or upgrades for operation PC downloadable via network or locally

Electronics: Realtime signal processor (RSP)
Microprocessor Motorola 68376, 20 MHz
Flash EPROM 1 MB
Static RAM 1 MB
Operating system Forth
Software Preinstalled. Modifications or upgrades downloadable via internal service interface

Interfaces
Communication 1 x Ethernet 10BaseT/TCP/IP
Control system coupling 1 x Modbus RS 485/RS 232 RTU/ASCII

Inputs/outputs: Basic equipment
Digital outputs (relay contact 0.4 A/24 V DC)
4, 3 x samples, 1 x calibration
Digital inputs (24 V to optocoupler) 4, for 1 = sample flow; 2 = time synchronization; 3 = revision (results have no effect on average values); 4 = calibration

Status indicator
LEDs for • Supply voltage
• Software Heartbeat
• Ready
• Maintenance request alert
• Fault
• Sample flow
LCD for • Sample stream: S1, S2, S3, S4
• Sample components: e.g. CO2, propane, etc.
• Measured value of sample as numeric value

Recommended operator panel
Personal computer Desktop or laptop
Processor At least Pentium III
Clock ≥ 800 MHz
Interfaces 1 x Ethernet
Operating system Windows XP, Windows 7
Software CV Control version 1.30.0.0 and higher
Notes on 7KQ3105-.. Support bracket
For easy mounting, incl. support for 8 gas connections consisting of:

- Mounting part: Dimensions 380 x 110 mm (W x H)
- Bracket for gas connection: Dimensions 146 x 110 mm (D x H), bracket on right side, mounted at right angle

Sample flow switchover
The chromatograph enables automatic selection and switchover of 3 sample flows and 1 calibration flow. The DO signal from the gas chromatograph requires an external relay for the solenoid valve. The sample preparation system can be ordered separately.

Ambient temperatures
Particularly in warmer zones, weather protection is necessary to protect the SITRANS CV against direct solar radiation.

The chromatograph is designed as standard for temperatures from -20 to +55 °C. A version in a thermostatically-controlled casing is also available as an option for temperatures outside these limits.

Communication
SITRANS CV has a serial interface (RS 485/RS 232) for MODBUS communication (RTU/ASCII). Modbus mapping can be flexibly used (see manual for more information).

The operator input is by means of another separate interface via Ethernet (TCP/IP).

Other serial and analog (4 to 20 mA) interfaces are optionally possible using an external solution package (see Article No. 7KQ2160).

Documentation
The documentation includes a SITRANS CV Manual and CVControl Operating Manual in English and German. The documents can be found on the enclosed CD.

Safety manuals in all EU languages are also available on the CD.

CVCControl operating software
The operating software (language: English or Russian) is included in the scope of supply. Windows XP or Windows 7 must be installed on the computer in order to install this software.

Application
A general system check is made of the basic unit and the integrated application module. The module and basic unit are described in the manual. In addition to the standard configuration, additional country-specific and user-specific sub-configurations are available. The performance record ex works contains the analysis check, including a repeatability record (4h test).

The chromatograph is preconfigured; In addition, three CD-ROMs are enclosed:

- SITRANS CV Software (including manuals and CVControl Operating Instructions)
- Country-specific sub-setups
- Parameter backup

Selection and ordering data Article No.

<table>
<thead>
<tr>
<th>SITRANS CV process gas chromatograph</th>
<th>7KQ3105-..</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic unit (incl. application module) mounted on mounting bracket</td>
<td>0</td>
</tr>
<tr>
<td>Explosion-proof, for Zone 1</td>
<td>1</td>
</tr>
<tr>
<td>Power supply 24 V DC</td>
<td>2</td>
</tr>
<tr>
<td>For 3 sample streams + 1 calibration stream</td>
<td>3</td>
</tr>
<tr>
<td>Explosion-proof, for ambient temperatures from -20 ... +55 °C</td>
<td>4</td>
</tr>
<tr>
<td>Stand-alone communication via 1 RS 485, RS 232 interface (MODBUS RTU, ASCII)</td>
<td>5</td>
</tr>
<tr>
<td>For post, pipe or wall mounting</td>
<td>6</td>
</tr>
<tr>
<td>Includes CV Control operating software (English)</td>
<td>7</td>
</tr>
</tbody>
</table>

Applications
- For standard calorific value analysis (N₂, CO₂, C1-C5, C6+)
- For extended calorific value analysis with oxygen (N₂, CO₂, O₂, C1-C5, C6+)
- For calorific value analysis with biomethane (N₂, H₂, CO₂, O₂, C1-C4)
- For calorific value analysis (N₂, CO₂, C1-C5, C6+) backflush summation

Additional versions Order code

- Add "Z" to Article No. and specify Order code
- Russian configuration
- Russian configuration for extended calorific value analysis
- Extended measuring range in combination with position 8_0 and position 8_1
- N₂, CO₂, C1-C5, C6, C7 (+)
- N₂, CO₂, C1-C5, C6, C7, C8, C9 (+)
- Acceptance and customer information (In agreement with application laboratory)
- Factory acceptance, 1 day
- Factory acceptance (performance record), 1 day
- Factory acceptance, every additional day
- Proof of repeatability
- Repeatability up to 8 h
- Repeatability up to 24 h
- Repeatability up to 48 h

Selection and ordering data Article No.

Analog data transmission and serial interface 7KQ2160-

| External module for generation of analog and serial interfaces | 0 |
| Click on the Article No. for the online configuration in the PIA Life Cycle Portal | 1 |
| Analog values via external unit (standard package) | 2 |
| 2 analog values | 3 |
| 4 analog values | 4 |
| 8 analog values | 5 |
| 16 analog values | 6 |
| 20 analog values A | 7 |
| MODBUS multiplexer Without multiplexer Without CE certificate With CE certificate | 8 |
| Enclosure Without protective casing With protective casing | 9 |

Additional versions Order code

- Add "Z" to Article No. and specify Order code
- Russian configuration
- Russian configuration for extended calorific value analysis
- Extended measuring range in combination with position 8_0 and position 8_1
- N₂, CO₂, C1-C5, C6, C7 (+)
- N₂, CO₂, C1-C5, C6, C7, C8, C9 (+)
- Acceptance and customer information (In agreement with application laboratory)
- Factory acceptance, 1 day
- Factory acceptance (performance record), 1 day
- Factory acceptance, every additional day
- Proof of repeatability
- Repeatability up to 8 h
- Repeatability up to 24 h
- Repeatability up to 48 h

Selection and ordering data Article No.

Analog data transmission and serial interface 7KQ2160-

| External module for generation of analog and serial interfaces | 0 |
| Click on the Article No. for the online configuration in the PIA Life Cycle Portal | 1 |
| Analog values via external unit (standard package) | 2 |
| 2 analog values | 3 |
| 4 analog values | 4 |
| 8 analog values | 5 |
| 16 analog values | 6 |
| 20 analog values | 7 |
| MODBUS multiplexer Without multiplexer Without CE certificate With CE certificate | 8 |
| Enclosure Without protective casing With protective casing | 9 |
Process Gas Chromatographs
SITRANS CV

Article No. Pos. 8_0: Applications – Standard calorific value analysis

This application comprises the standard calorific value analysis. The chromatograph’s measurement method is set at the factory, using a synthetic natural gas mixture. The performance parameters specified in Table 5 and the criteria explained in the subsequent text apply to the individual components in Table 1 and their physical variables.

The calculation of the calorimetric variables is possible according to the following standards: ISO 6976-95, GOST AGA 8, where the former is preset. The reference states for the combustion and for the gas volume that must be specified for calculation purposes are preset to the standard state (Tb=25 °C, Tn= 0 °C) and can be easily changed to other reference states during commissioning using the operating software (Tb= operating temperature, Tn= standard temperature).

The CVControl software provides the energy units BTU/ft³, KWh/m³ and MJ/m³.

Article No. Pos. 8_1: Applications – extended calorific value analysis with oxygen

This position includes the extended calorific value analysis of the components and possible working ranges from Table 1. Oxygen is measured in addition to the listed components (see Table 2).

A carrier gas dry filter (Article No. filter set A5E00400116) on the mounting bracket of the SITRANS CV or enclosed separately is used as standard for this measurement.

The remarks concerning oxygen and CO in footnote 1 of Table 1 are no longer applicable to this position. The information concerning calculation and performance parameters are identical to Pos. 8_0.

Important:

For correct operation of SITRANS CV in accordance with Pos. 8_0 and 8_1, all measured components must be present in the calibration gas. The calibration gases listed in the table "Recommended calibration gases for Pos. 8_0 and 8_1" are recommended (also see Table 6):

<table>
<thead>
<tr>
<th>Component</th>
<th>Pos. 8_0 (mol%)</th>
<th>Pos. 8_1 (mol%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Methane</td>
<td>88.9</td>
<td>88.4</td>
</tr>
<tr>
<td>Ethane</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Propane</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>N-butane</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Neopentane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Isopentane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>N-pentane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>N-hexane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 7: Recommended calibration gases for Pos. 8_0 and 8_1

A summary of the various country-specific setups, i.e. standard settings including measured components and calibration gases, can be found on the parameter backup CD in the "Readme.pdf" document.

Article No. Pos. 8_2: Applications – Calorific analysis with biomethane

This position contains the analysis of the components and working ranges of the biomethane listed in Table 3. Based on the measured concentrations of the components, the quality parameters – such as heating values – are determined in accordance with the international standards ISO, GOST and AGA analogously to positions 8_0 and 8_1.

Article No. Position 8_3: Applications – Calorific value analysis with backflush summation

This position includes the analysis of the components listed in Table 4, in which case the components starting from C6, including the isomers, are regarded as the sum peak. This variant is especially well suited for natural gases with very low content of higher hydrocarbons, especially C6+.

However, this backflush summation can also be used to effectively analyze natural gas with typical C6+ fractions. The components up to and including C6+ can be analyzed within the possible concentration ranges according to Table 4.

A01 – SITRANS CV for calorific value analysis Pos. 8_0, 8_1, 8_2 and 8_3 – Russian configuration

This position includes the possibility for ordering SITRANS CV with a Russian Ex certificate.

IMPORTANT: This Russian version results in a change in the nomenclature from SITRANS CV to MicroSAM.

The following also applies to Pos. 8_3:

The limits listed in GOST Standard 31371.7-2008 are checked during the inspection and supplied with the device documentation.

B02: SITRANS CV with extended measuring range in combination with Pos. 8_0

This position permits separate measurement of the group isomers of the higher hydrocarbons C6 to C7(+) and C6 to C9 (+). In accordance with the designation C7(+) and C9 (+), a detailed measurement is carried out up to and including n-C9.

Important:

Testing and certification of the SITRANS CV is carried out using the standard calorific value analysis in accordance with Pos. 8_0. If Pos. D02 or D03 has been selected, this does not include repetition of the proof of repeatability (4 h test) of the unit during the factory acceptance.

The following calibration gases are essential for operation of the SITRANS CV including these extended measuring ranges:

<table>
<thead>
<tr>
<th>Required components</th>
<th>Calibration gas for C6 and C7(+) measurement (mol%)</th>
<th>Calibration gas for C6 and C9(+) measurement (mol%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Methane</td>
<td>89.00</td>
<td>89.00</td>
</tr>
<tr>
<td>Ethane</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Propane</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Isobutane</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>n-butane</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Neopentane</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Isopentane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>N-pentane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>N-octane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>N-nonane</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 8: Components and concentrations of the calibration gases for the extended measuring ranges

Further information regarding startup of SITRANS CV including C7(+) and C9(+) measurement can be found in the manual and on the enclosed document CD (country-specific setup "Readme.pdf" file).
D01 - Acceptance and customer information - Factory acceptance, visual check, 1 day

The scope of supply is checked and the documentation and operation of the unit explained as part of the factory acceptance process. The factory acceptance does not include repetition of the test of repeatability (4 h test) of the unit.

D02 - Acceptance and customer information - Factory acceptance with performance record, 1 day

The scope of the tests to be carried out is described in Table 9 "Scope of tests during factory acceptance". When ordering D02, please supplement the desired option from E0x.

| Record of component isolation | Through a final check of existing documentation and according to current chromatograms, 5 analyses |
| Stability test (repeatability) | According to order E01 ... E03 Performance criteria according to page 5/28 ff. |
| Checking the Modbus connection | Checking or simulation of Modbus communication can be carried out using a flow computer provided by the customer, for example. |
| Calculation test | Comparison of the values calculated by CVControl with a customer comparison procedure (optional) |
| Auto-calibration function | The two functions are explained theoretically and practically during presentation of CVControl. |
| Auto-optimization of method | |
| Alarm and event messages | Simulation of alarm situations; as per customer requirement |

Table 8: Scope of test during factory acceptance

SITRANS CV is a standard product. Only in this manner is it possible to guarantee short delivery times and attractive prices. All performance records required retrospectively require higher overhead. However, will be happy to come to an agreement regarding implementation.

D03 - Acceptance and customer information - Factory acceptance, each additional day

Only in conjunction with D01 or D02

E0x - Repeatability test

Proof of repeatability over a period of 4 h is included as standard. Longer repeatability records for the unit can be ordered by means of the supplementary item E0x.

E01 to E03 - Repeatability test, 8 h – 24 h – 48 h

Only in conjunction with D02

Linearity tests can be carried out in the factory on request. The standard calibration gases required for this (Table 10: "Recommended calibration gases for linearity test during acceptance") are provided free of charge. If the customer specifies other calibration gases with different compositions or higher uncertainty requirements, they must provide these gases for acceptance purposes. As an option, Siemens can procure these special calibration gases (subject to a charge).

On request, proof of the complete functionality of the SITRANS CV is possible within the certified temperature and ambient conditions.

### Table 9: Components of the factory acceptance

<table>
<thead>
<tr>
<th>Component</th>
<th>Gas #1 (Mol.%)</th>
<th>Gas #2 (Mol.%)</th>
<th>Gas #3 (Mol.%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>Residual (approx. 75)</td>
<td>Residual (approx. 85)</td>
<td>Residual (approx. 96.5)</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>15.5</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0.5</td>
<td>2</td>
<td>0.1</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Ethane</td>
<td>8</td>
<td>4</td>
<td>0.5</td>
</tr>
<tr>
<td>Propane</td>
<td>0.5</td>
<td>2</td>
<td>0.15</td>
</tr>
<tr>
<td>i-butane</td>
<td>0.15</td>
<td>0.5</td>
<td>0.03</td>
</tr>
<tr>
<td>n-butane</td>
<td>0.15</td>
<td>0.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Neopentane</td>
<td>0.08</td>
<td>0.3</td>
<td>0.03</td>
</tr>
<tr>
<td>i-pentane</td>
<td>0.08</td>
<td>0.3</td>
<td>0.03</td>
</tr>
<tr>
<td>n-pentane</td>
<td>0.08</td>
<td>0.3</td>
<td>0.03</td>
</tr>
<tr>
<td>Hexane</td>
<td>0.05</td>
<td>0.1</td>
<td>0.015</td>
</tr>
</tbody>
</table>

Table 10: Recommended calibration gases for linearity test during acceptance

The calibration gases have the following uncertainties:

<table>
<thead>
<tr>
<th>Proportions of component materials (Mol.%)</th>
<th>Uncertainty (or smaller)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 ... 0.25</td>
<td>± 5.00 %</td>
</tr>
<tr>
<td>0.25 ... 1</td>
<td>± 1.00 %</td>
</tr>
<tr>
<td>1 ... 10</td>
<td>± 0.50 %</td>
</tr>
<tr>
<td>10 ... 100</td>
<td>± 0.20 %</td>
</tr>
</tbody>
</table>

Table 11: Uncertainties of calibration gases

Notes on 7KQ2160-..

**Analog and serial data transmission.**

SITRANS CV does not provide internal analog outputs. These properties can be provided by the SIMATIC Extension Unit. This uses the Modbus output of the chromatograph in order to generate up to 8 active analog outputs (standard, more analog outputs on request).

Modbus multiplexers are available in addition, and allow up to 2 Modbus masters to be connected to the SITRANS CV. The distance from the SITRANS CV should not be more than 1 200 m. In the case of an installation without enclosure (without explosion protection), we deliver the components for generation of analog outputs mounted on a rail, otherwise in the Ex d enclosure.

**Pos. 08_0 - 5 – Analog values via external unit**

This position includes:
- Mounting rail
- Power supply
- SIMATIC S 7-300 and SIMATIC S7, Micro Memory Card 3.3 V NFLASH, 64 KB
- Analog output module with terminating connector
- Protocol converter

**Pos. 09_ A – C: Modbus multiplexer**

(only applicable together with 0-4)

The Modbus signal can be routed using the Modbus multiplexer and connected to two Modbus masters. B specifies supply of the components without CE certificate.

**Pos. 10_ A - B: Enclosure**

This position includes the option for installation of the SIMATIC extension unit in the hazardous area (Zone 1 and Zone 2). A protective casing Ex d with standard cable glands including the modules required for the analog outputs and the Modbus multiplexer (if applicable) are provided for this purpose.
Process Gas Chromatographs
SITRANS CV

Dimensional drawings

SITRANS CV, dimensions in mm