Process Gas Chromatographs

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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.

MAXUM edition II

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 CS_2 and H_2S 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: Chromatographic determination of the calorific value
- 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:

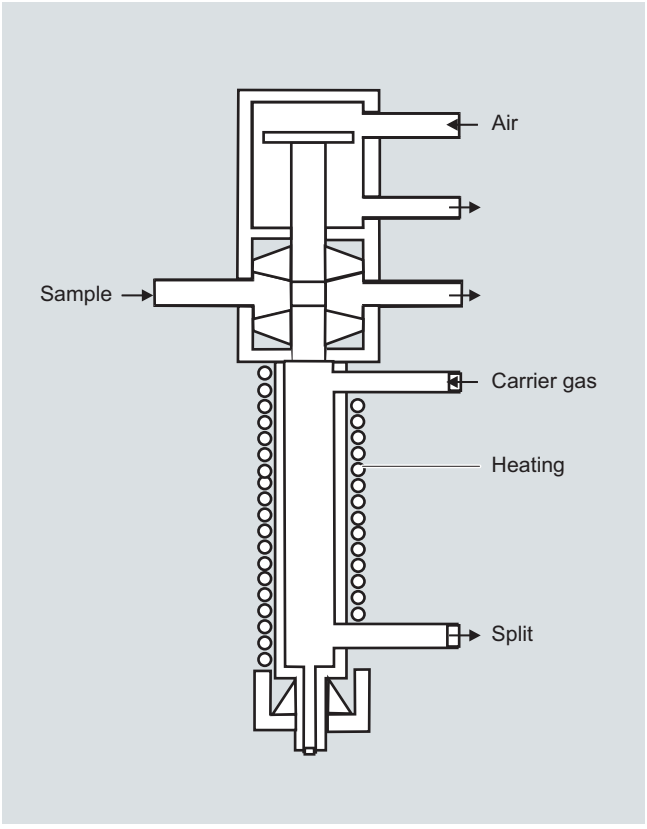
- Can be used as gas injection valve, liquid injection valve or for column switching
- Membrane controlled by tappet
- One million switching cycles without maintenance

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



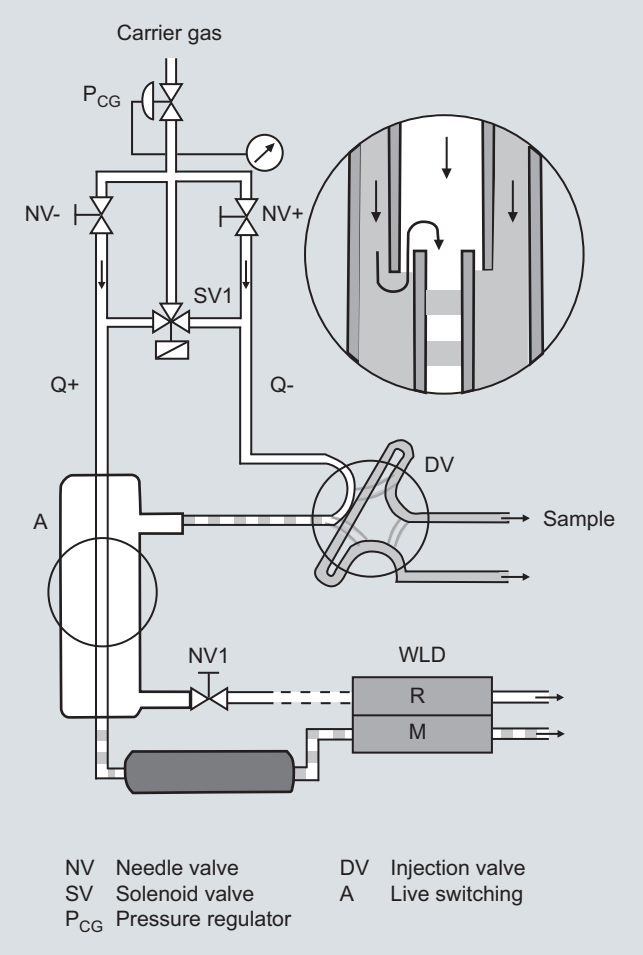
Liquid injection valve FDV

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.



Live injection

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.

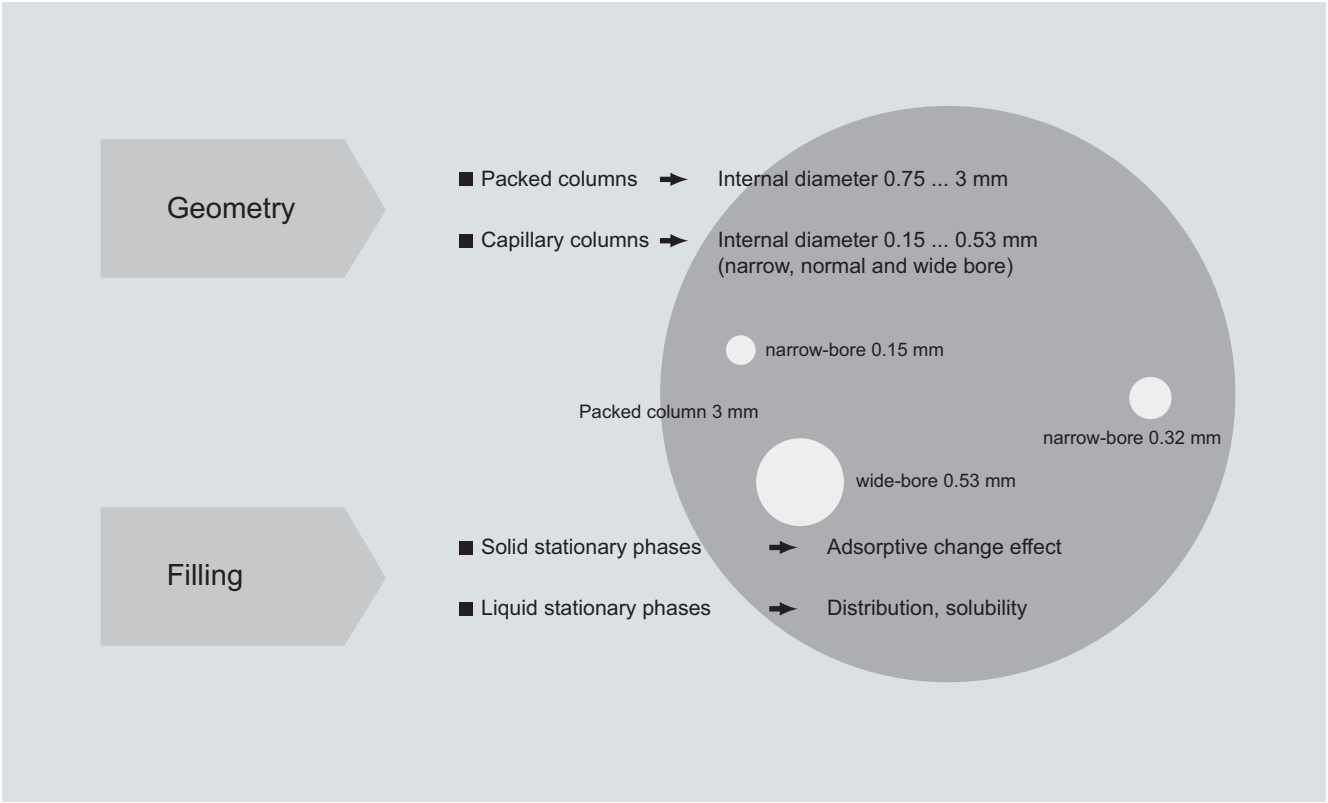
"Simulated distillation" is an important application of PTGC in refineries. The distillation range - a quality criterion for fuels - is chromatographically traced "online".

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

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:

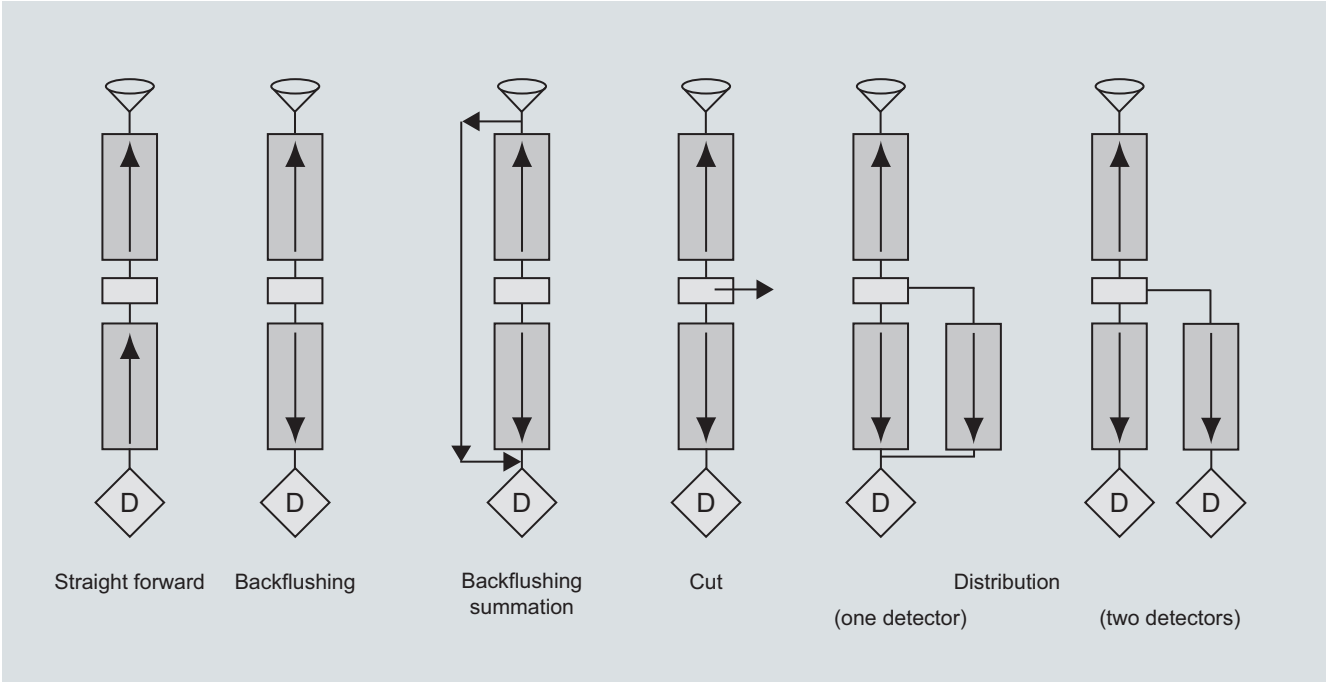
- Can be used as gas injection valve, liquid injection valve or for column switching
- Membrane controlled by tappet
- One million switching cycles without maintenance

Valveless switching technique

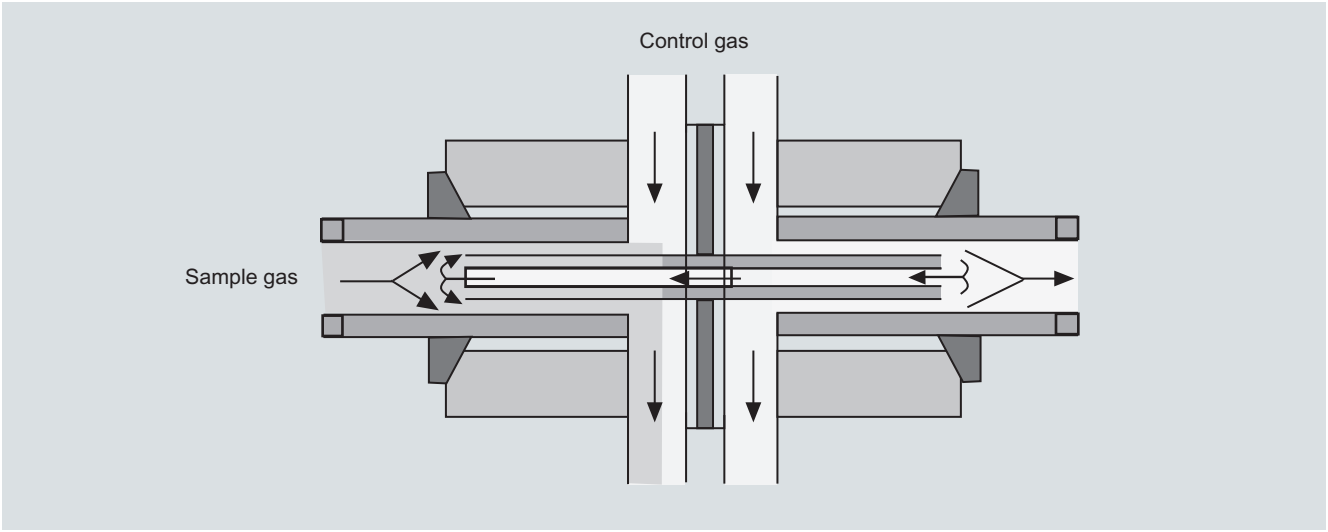
The valveless live column switching is exactly controlled by electronic pressure regulators, and prevents falsification of results since the sample does not come into contact with valves. A special pressure-controlled coupling element connects the capillary columns.

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.



Column switching systems (examples)



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)

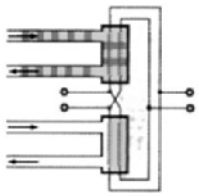
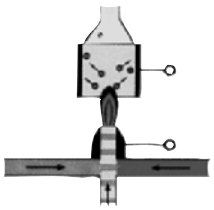
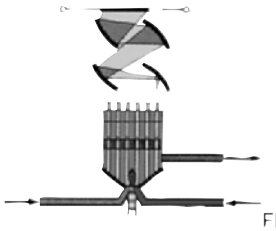
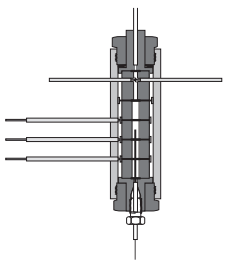
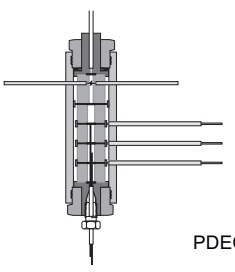
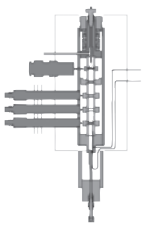
- Permits exact control of pressure without mechanical pressure regulator. Shortens the setup time since the pressure is set by an operator input.
- Permits programmable pressure changes for fast chromatography and modern applications.
- Controls the supply of carrier gas and combustion gas. Avoids drift 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.

Detector	Measured value dependent on:	Selectivity	Application example
 WLD	Concentration	Universal	Main and subsidiary components
 FID	Mass flow	Thermally ionizable components at < 1 000 °C	Hydrocarbons
 FPD	Mass flow	Substances containing S or P	Traces of sulfur in HC matrices
 PDHID	Mass flow	Universal (except He and Ne)	Ultra-pure gas analysis
 PDECD	Mass flow	Molecules with electronegative groups	Traces of halogenated hydrocarbons
 PDPID	Mass flow	Selective, dependent on ionization potential	Traces of aromatic compounds, amines

Suitable detectors for process gas chromatography

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 (referred 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.

- PDHID (helium ionization detector)
  The PDHID 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 PDHID 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).
- PDPID (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 (H_2O, CO_2) 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	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

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: 1 120 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 (EEx pyedmib IIB + H_2) • 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 columns
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 Max. 0.3 µm with liquid samples
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	
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
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 analog outputs; • 4 digital outputs (1 for output of system faults, 3 are user-configurable); • 4 digital inputs; • 3 serial outputs
Card slots for optional inputs and outputs via internal I2C bus	2
Input and output cards	A IO 8: 8 analog outputs, 8 analog inputs, 2 digital inputs D IO: 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 (12 … 24 V DC); 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_{in} = 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 mm^2

Climatic conditions	
Ambient temperature	-18 ... 50 °C
Gas supply	
Instrument air	• At least 350 kPa for units with valves Model 11 or Valco • At least 825 kPa for units with valves Model 50 • At least 175 kPa for airbath ovens; 85 l/min per oven • 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
Combustion gas	• Hydrogen with a purity of 99.999 % • Typical consumption quantity: 2 000 l/month per detector module
Combustion air	• Reference air (< 1 ppm THC, O_2 concentration 20 … 21 %). Supply through instrument air with catalytic purification (optional). • Typical consumption quantity: 26 000 l/month
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)
Communication	
Serial output	RS 232, RS 485, e.g. Modbus
Ethernet	Standard 10/100 BaseT Ethernet with 4 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.

MAXUM edition II

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

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: 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 (EEx pyedmib IIB + H_2) • 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 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

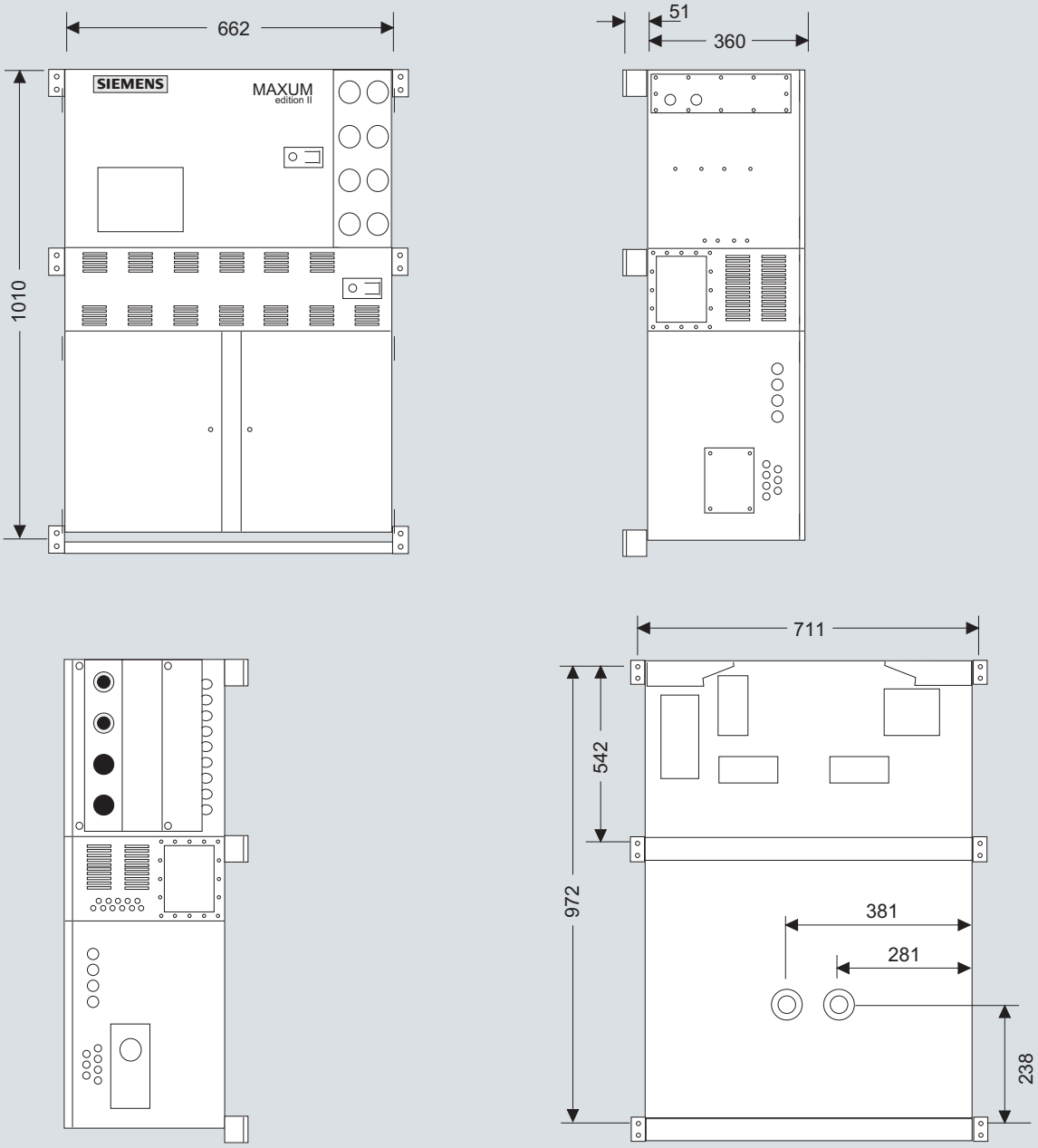
Influencing variables	
Effects of ambient temperature	None with electronic pressure control Different effects with mechanical pressure control (depending on application)
Electrical inputs and outputs	
Standard input and output	• 2 digital outputs (1 for output of system faults, 1 is user-configurable); • 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 IO 8: 8 analog outputs, 8 analog inputs, 2 digital inputs D IO: 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_{in} = 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 mm^2

Climatic conditions	
Ambient temperature	-18 ... 50 °C
Gas supply	
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)
Communication	
Serial output	RS 232, RS 485, e.g. Modbus
Ethernet	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.

Selection and ordering data

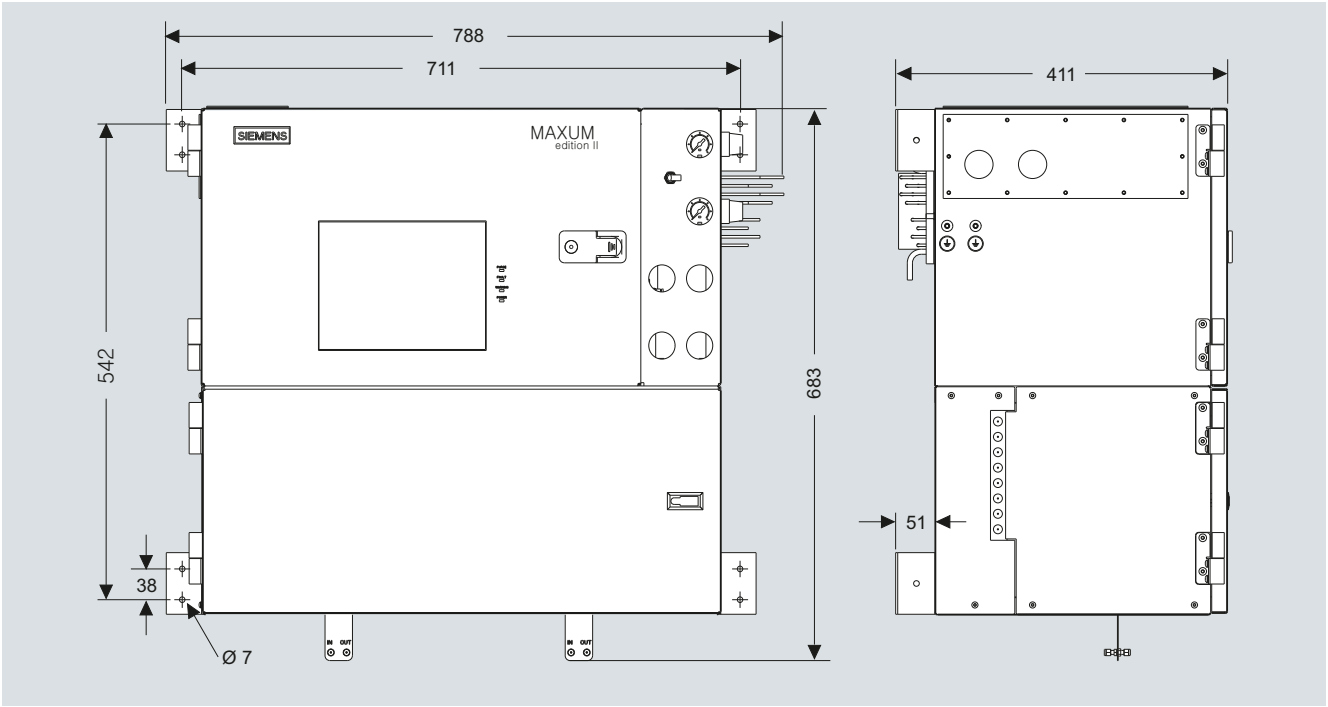
Please contact your Siemens sales partner to order a device.

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

MicroSAM

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 infra-structure
- Reduction in laboratory analyses through online measure-ments
- 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 C_2 splitter of a steam cracker
- Analysis of low-boiling hydrocarbons in an ethylene plant/ visbreaker
- 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 O_2, N_2, CO_2 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 (according to ATEX II 2G)
- 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 standardized application modules all contain live injection and live switching. The modules D01 to D03 have four detectors and three separating columns, D04 to D08, D10 and D11 have three detectors and two separating columns, and D09 has three detectors and three separating columns.

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

	Detector	Column 1	Detector	Column 2	Detector	Circuit	Column 3	Detector
D01								
Injection	TCD	Sil5 C3, C4, C5, C6+	TCD	PoraPLOT/Porabond Q CO_2, C2, H_2O	TCD	Live	Molecular filter H_2, (Ar+O_2), N_2, C1, CO	TCD
D02								
Injection	TCD	Sil5 C5+	TCD	SilicaPLOT C2, C3, C4 (saturated, unsaturated), C5+	TCD	Live	Molecular filter H_2, (Ar+O_2), N_2, C1, CO	TCD
D03								
Injection	TCD	Sil5 C5+	TCD	Wax Volatile pole components such as alcohol, ether, ketones, aldehydes, C7+	TCD	Live	ALOX C1, C2, C3, C4 (saturated, unsaturated)	TCD
D09								
Injection	-	Sil5 Non-polar aromatic and aliphatic hydrocarbons	TCD	Sil5 Non-polar aromatic and aliphatic hydrocarbons	TCD	Live	Porabond Q All components except molecular filter components	TCD

Application modules D01 to D03 and D09

	Detector	Column 1	Detector	Circuit	Column 2	Detector
D04						
Injection	TCD	Wax Volatile pole components such as alcohol, ether, ketones, aldehydes, C7+	TCD	Live	SilicaPLOT C_2, C_3, C_4, C_5, C_6 (saturated, unsaturated)	TCD
D05						
Injection	TCD	Wax Polar aromatic and aliphatic hydrocarbons	TCD	Live	Wax Polar aromatic and aliphatic hydrocarbons	TCD
D06						
Injection	TCD	Sil5 Non-polar aromatic and aliphatic hydrocarbons	TCD	Live	Sil5 Non-polar aromatic and aliphatic hydrocarbons	TCD
D07						
Injection	TCD	Wax Polar aromatic and aliphatic hydrocarbons	TCD	Live	Sil5 Non-polar aromatic and aliphatic hydrocarbons	TCD
D08						
Injection	TCD	Porabond Q All components except molecular filter components	TCD	Live	Molecular filter H_2, (Ar+O_2), N_2, C1, CO	TCD
D10						
Injection	TCD	Sil5 Non-polar aromatic and aliphatic hydrocarbons	TCD	Live	Wax Polar aromatic and aliphatic hydrocarbons	TCD
D11						
Injection	TCD	RTX-5+ RTX-200 Non-polar aromatic and aliphatic hydrocarbons and medium-pole components such as chlorosilane	TCD	Live	SilicaPLOT C_2, C_3, C_4, C_5, C_6 (saturated, unsaturated)	TCD

Application modules D04 to D08, D10 and D11

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	
Weight	15 kg
Degree of protection	IP65 (NEMA 4X)
Mounting	
Installation on	Post, pipe or wall
Distance from wall or next chromatograph	300 mm (12")
Distance from ceiling or floor	200 mm (8")
Explosion protection	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
Support bracket	
• Mounting part, dimensions (D x H)	380 x 110 mm
• Gas connections	8
• Bracket for gas connection, dimensions (D x H), bracket on right side, mounted at right angle	146 x 110 mm
Electrical characteristics	
Power supply	24 V DC (18.5 ... 30.2 V)
Power consumption	
• Typical	18 W
• Maximum	60 W
• Electrical safety	IEC 61010 / DIN VDE 0411
EMC immunity	According to IEC 60801/ DIN VDE 0843
• Conducted interferences on AC supply lines	
- According to Part 4 (burst)	2 kV
- According to Part 5 (ms pulses), line against line	1 kV
- According to Part 5 (ms pulses), line against ground	2 kV
• Conducted interferences on signal lines	
- According to Part 4 (burst)	1 kV
• Immunity to static discharge	
- According to Part 2 (ESD)	8 kV
• Immunity to fields	
- According to Part 3 and Part 6	10 V/m
• Noise suppression	According to CISPR 11 / EN 55011 / DIN VDE 0875 Limit class B
• Fuse	T2.5 A
Gas inlet conditions	
Permissible sample pressure	10 … 60 kPa above atmosphere
Sample flow	20 … 100 ml/min
Max. sample temperature	120°C
Solid components	< 0.1 mm
Climatic conditions	
Permissible ambient temperature	- 20 ... 50 °C (depending on oven temperature)
Permissible storage/transport temperature	- 30 ... 70 °C
Permissible relative humidity	Max. 90 %

Sample and injection	
Sample streams	3
Calibration sample streams	1
Phase	Gaseous
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
• Controller	With multifunctional diaphragm valve
• Injection volume adjustable using switching times	2 ... 50 µl
• Max. operating temperature	165 °C
Oven	
Number/type	1/isothermal
Purging with N_2	Possible
Dimensions (DxH)	160 x 10 mm
Heating capacity	20 W
Temperature range	60 … 155 °C
Temperature stability	± 0.1 K (60 ... 155 °C)
Temperature accuracy	± 3 K (60 ... 155 °C)
Retention time variations per 10 °C change in ambient temperature	Approx. 0.3 %
Heating-up period from 30 ... 100 °C	10 minutes
Columns and gases	
Column type	Capillary columns 0.15 ... 0.25 mm/ internal
Separating column switching	Multidimensional chromatography with backflushing and cut in live system
Multifunctional diaphragm valve	For injection and backflushing
Gas connections	Swagelok 1/8"
Pressure regulators	Max. 4 single-channel electronic pressure regulators
Solenoid valves for control of diaphragm valve	2 NC contacts, 2 NO contacts
Carrier gas	H_2, N_2, He, Ar
• 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	10 ... 60 ml/min
• Inlet pressure	500 …700 kPa (g) 600 kPa (g) recommended
	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.
Instrument air	Not required

Detectors, calibration and performance data	
Detector type	TCD, max. 8 sensors
Ambient temperature	Negligible
Vibrations	Negligible
Cell volume	0.02 µl
Calibration	Manual or automatic, single-level or multi-level
Smallest measuring range	1 000 ppm (application-dependent)
Linear range	Typically > 10^4
Cycle time	Typically 30 … 240 s
Electrical inputs and outputs	
Basic equipment	
• Digital outputs (relay contact 0.4 A / 24 V DC)	4, freely usable (expandable by NAU or I/O Extender, see Communication in "General information")
• Digital inputs (24 V to optocoupler)	4, 3 freely usable (expandable by NAU or I/O Extender, see Communication in "General information")
Interfaces	
• Communication	1 x Ethernet 10BaseT / TCP/IP
• Control system coupling	1 x RS 485 or RS 232 / Modbus RTU, OPC (ODPC) over Ethernet
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
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
Controller	
• Sample streams	3
• Calibration sample streams	1
• Status LEDs for	• Supply voltage • Software sign-of-life • Operational readiness • Maintenance request alert • Fault • Sample flow
• LCD display for	• Sample stream: S1, S2, S3, S4 • Sample components: e.g. CO_2, 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 or 7
• Software	Gas chromatograph portal, from version 1.02

Selection and ordering data	Order No.
MicroSAM process gas chromatograph 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	**7KQ3101-** ■■
Sample	
For gaseous sample	**0**
For gaseous sample (standard UKOG)	**8**
Workstation operating software (1 workstation operating software required per GC network)	
Without operating software	**A**
With workstation operating software	**B**

Additional versions	Order code
Add "-Z" to Order No. and specify order codes.	
Application modules	**D01 to D11**
See description at function of application modules	
Standard applications with defined hardware	
Method development in the application	
Standard	**C01**
Special application[1)]	**C04**
Acceptance and customer information (in agreement with application laboratory)	
Remote acceptance	**J01**
Factory acceptance, 1 day	**J02**
Factory acceptance, 2 days	**J03**
Factory acceptance, 3 days	**J04**
Repeatability test	
Standard (2 hours)	**E01**
Up to 8 hours	**E02**
Up to 24 hours	**E03**
Up to 72 hours	**E03**
Data transmission	
Modbus mapping (during commissioning)	**F01**
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	**K01**
Analog values via external unit (standard package 1); Zones 1 and 2 4 digital inputs, 4 digital outputs, 2 analog inputs, 4 analog outputs	**K02**
Analog values via external unit (standard package 2); Zones 1 and 2 12 digital inputs, 12 digital outputs, 6 analog inputs, 12 analog outputs	**K03**
Analog values via external unit (standard package 3); Class I Div 2 4 digital inputs, 4 digital outputs, 2 analog inputs, 4 analog outputs	**K04**
Analog values via external unit (standard package 4); Class I Div 2 12 digital inputs, 12 digital outputs, 6 analog inputs, 12 analog outputs	**K05**
Miscellaneous calculations and functions using BASIC interpreter integrated in the GC	
MicroSAM Basic Editor	**H01**
Application setup: Calculations in accordance with ISO 6976-95	**H02**
Application setup: Natural gas - calculations in accordance with GPA 2172-96	**H03**
Application setup: Natural gas - calculations in accordance with GOST 22667-82	**H04**
Application setup: Natural gas - customer-specific calculations	**H05**

[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 PA 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/m^3 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/ft^3 (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

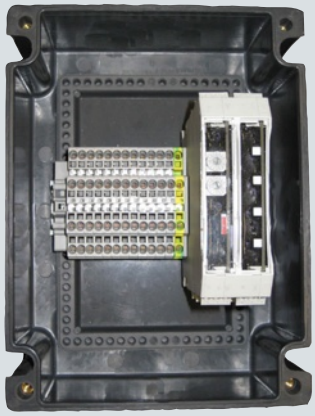
An unambiguous description of the task is required in order to guarantee correct functioning of the program.

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.

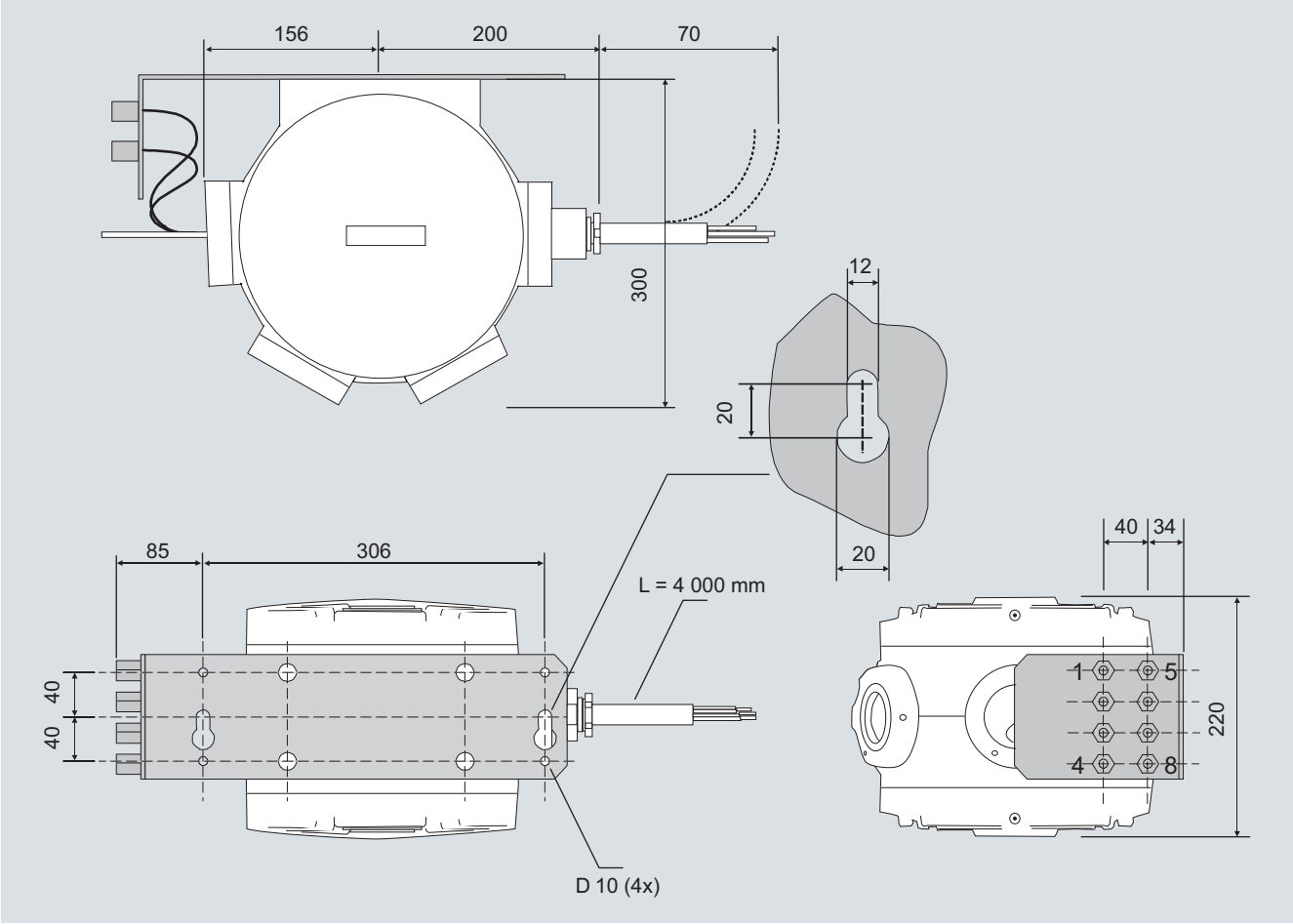
	Calibration gas I in vol.%	Calibration gas II in vol.%	Calibration gas III in vol.%
1.2-butadiene	–	–	0.1
1.3-butadiene	–	–	0.1
1-butene	–	–	0.1
2.2 dimethylpropane	0.3	0.3	–
cis-2-butene	–	–	0.1
Cyclopropane	–	–	0.1
Ethane	4	4	0.1
Ethene	–	–	0.1
Ethine	–	–	0.1
Ethyl acetylene	–	–	0.1
Helium	–	–	Remainder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

Standard calibration gases for system test and run-out



Box with I/O Extender

Dimension drawings



MicroSAM, dimensions in mm

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

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.

Like the MicroSAM, the SITRANS CV consists of a basic unit and an analysis module, which, if necessary, can be replaced in as short a time as possible. Combined with low power and gas consumption, this keeps operating costs down.

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

The automatic method optimization integrated in the software increases the repeatability of the calorific value measurement and reduces the cost of ownership.

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.

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

Design

Enclosure

- EEx-d version standard (acc. to ATEX II 2G)
- 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)

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 column system consists of 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 (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.

Modules

The standardized application modules generally feature live injection and live switching functions, detectors and three separating columns.

	Detector	Column 1	Detector	Column 2	Detector	Circuit	Column 3	Detector
C09		Sil5	TCD	Sil5	TCD	Live	Porabond Q	TCD
Injection		Non-polar aromatic and aliphatic hydrocarbons		Non-polar aromatic and aliphatic hydrocarbons			All components except molecular filter components	
C01	TCD	Sil5	TCD	PoraPLOT/Porabond Q	TCD	Live	Molecular filter	TCD
Injection		C3, C4, C5, C6+		CO_2, C_2, H_2O			H_2, (Ar+O_2), N_2, C1, CO	

Application

The SITRANS CV is a storage product. Precalibration is carried out at the factory, using helium and argon (as the carrier gas) and a calibration gas. The measured components and switching functions (live injection, backflushing, cut) are saved in the GC. The calibration process itself should be performed during commissioning on-site.

Measurements can be made within the following working ranges:

Component	Checked working range (%)	Possible working range (%)
Methane	57 ... 100	50 ... 100
Nitrogen[1)]	0 ... 22	0 ... 25
Carbon dioxide	0 ... 12	0 ... 20
Ethane	0 ... 14	0 ... 20
Propane	0 ... 5	0 ... 15
i-butane	0 ... 0.9	0 ... 10
n-butane	0 ... 1.8	0 ... 10
Neopentane	0 ... 0.1	0 ... 1
i-pentane	0 ... 0.12	0 ... 1
n-pentane	0 ... 0.12	0 ... 1
Hexane+[2)]	0 ... 0.08	0 ... 3
Hexane		0 ... 1
Heptane+[3)]		0 ... 1
Octane		0 ... 1
Nonane+[4)]		0 ... 1
Helium	Concentration can be entered as a fixed value in the components list	
H_2S	< 500 ppm	No measured component
High/low calorific value	Calculated	Calculated
Density and relative density	Calculated	Calculated
Wobbe index	Calculated	Calculated
Compressibility factor	Calculated	Calculated
Normalisation factor	Calculated	Calculated

Table 1: Measured components and performance parameters for Pos. 8_0 (master setup, standard calorific value analysis in accordance with ISO 6976-1995)

1) Any oxygen or carbon monoxide present in the sample will be detected along with the nitrogen and, therefore, taken into account when the nitrogen concentration is determined.

2) Hexane+ = $group_{(iso/n\text{-}hexane\ to\ iso/n\text{-}nonane)}$

3) Heptane+ = $group_{(iso/n\text{-}hexane)}$ and $group_{(iso/n\text{-}heptane\ to\ iso/n\text{-}nonane)}$

4) Nonane+ = $group_{(iso/n\text{-}hexane)}$, $group_{(iso/n\text{-}heptane)}$, $group_{(iso/n\text{-}octane)}$, $group_{(iso/n\text{-}nonane)}$

Component	Possible working range (%)
Oxygen	0 ... 4

Table 2: Measuring range of the additional measured component oxygen of the extended calorific value analysis (see Order No. 7KQ3105-1)

The remark in footnote 1 about the detection of oxygen and nitrogen is not valid in the case of an extended calorific value analysis. In this case, all components from the Table "Measured components and performance parameters for Pos. 8_0 (master setup, standard calorific value analysis in accordance with ISO 6976-1995)" plus oxygen are detected and quantified.

For the analysis of biomethane the following components and their working ranges are measured (Table 3).

Component	Possible working range (%)	Calibration gas for biomethane measurement (%)
Methane	> 80	89
Nitrogen	< 8	4
Ethane	< 6	2.5
Carbon dioxide	< 4	2.5
Propane	< 5	1.0
Butane	< 1.2	0.2
Oxygen	< 3	0.2
2-Methylpropane (isobutane)	< 0.7	0.2
Hydrogen	< 3	0.2

Table 3: Measured components, working ranges and calibration gas for the analysis of biomethane

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 Order 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)".

Concentration range (mol.%)	Repeatability according to ISO 6974-5 (2001); molar fraction (%), absolute
$50 < x_i < 100$	0.1
$1 < x_i < 50$	0.011
$0.1 < x_i < 1$	0.006
$x_i < 0.1$	0.006

Table 4: The repeatability of the measured components complies with ISO 6974-5 (2001) – Annex B (Order 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 %.

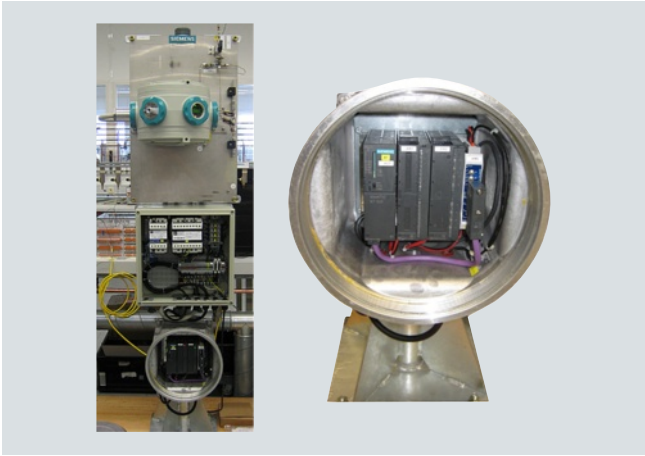
SITRANS CV is designed for measuring with various configurations; the calibration gases required for this purpose are shown below. (Table 5, Measurement and calibration gas components):

SITRANS CV – Overview of possible configurations and the required calibration gases

Carrier gas	He							He					Ar
Analyzer module	C09							C01					C01
Analysis time	100 s							150 s					180 s
	Default	Country-specific setup (can be configured by the customer)						Default	Country-specific setup (can be configured by the customer)				Default
Calculation standard	ISO 6976	ISO 6976	ISO 6976	GOST.3 0319	AGA 8	ISO 6976	ISO 6976	ISO 6976	ISO 6976	ISO 6976	ISO 6976	ISO 6976	ISO 6976
Order No.	**7KQ 3105-0**					**7KQ 3105-0B02**		**7KQ 3105-1**			**7KQ 3105-1B02**		**7KQ 3105-2**
Hydrogen	-	-	-	-	-	-	-	-	-	-	-	-	M CR
Oxygen	-	-	-	-	-	-	-	M CR	M CR	M CR	M CR	M CR	M CR
Nitrogen	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR
Carbon dioxide	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR
Methane	M CR	M CR	M CR	M^{+6}	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR
Ethane	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	-	M CR	M CR	M CR
Propane	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	-	M CR	M CR	M CR
Isobutane	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	-	M CR	M CR	M CR
Butane	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	-	M CR	M CR	M CR
Neopentane	M CR	M^{+2}	M^{+2}	M^{+2}	M CR	M CR	M CR	M CR	M^{+2}	-	M CR	M CR	-
Isopentane	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	-	M CR	M CR	-
Pentane	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	M CR	-	M CR	M CR	-
Hexane	CR	CR	-	-	CR	CR	CR	CR	CR	-	CR	CR	-
Group C6+	M^{+1}	M^{+1}	M^{+3} CR	M^{+3} CR	M^{+1}	-	-	M^{+1}	M^{+1}	-	-	-	-
Group C6	-	-	-	-	-	M^{+4}	M^{+5}	-	-	-	M^{+4}	M^{+5}	-
Heptane	-	-	-	-	-	CR	CR	-	-	-	CR	CR	-
Group C7+	-	-	-	-	-	M^{+4}	-	-	-	-	M^{+4}	-	-
Group C7	-	-	-	-	-	-	M^{+5}	-	-	-	-	M^{+5}	-
Octane	-	-	-	-	-	-	CR	-	-	-	-	CR	-
Group C8	-	-	-	-	-	-	M^{+5}	-	-	-	-	M^{+5}	-
Nonane	-	-	-	-	-	-	CR	-	-	-	-	CR	-
Group C9	-	-	-	-	-	-	M^{+5}	-	-	-	-	M^{+5}	-

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 PA 01 – SITRANS CV - Function
M^{+1}	Group C6+ is measured with response factor of hexane
M^{+2}	Neopentane is measured with response factor of isopentane
M^{+3}	Group C6+ is calibrated with certified natural gas
M^{+4}	Groups C6 and C7+ are measured separately with response factor of hexane and heptane
M^{+5}	Groups C6, C7, C8 and C9 are measured separately with response factor of hexane, heptane, octane and nonane
M^{+6}	Methane is calculated as a balance value to 100 %. During the calibration, methane is only used for the automatic optimization of the method.

Table 5: Overview of device versions and available measurement configurations and the calibration gas compositions required for them



SITRANS CV with SIMATIC Extension Unit

Technical specifications

Climatic conditions	
Permissible ambient temperature	-20 ... +55 °C (depending on oven temperature)
Permissible storage/transport temperature	-30 ... +70 °C
Permissible relative humidity	Max. 90 %
Protection against dust and moisture	
• According to EN 60529/IEC 60529	IP 65
• According to NEMA 250	NEMA 4X
Power supply	
Power supply	24 V DC (18.5 ... 30.2 V)
External fuse	T2.5 A
Power consumption, typical	18 W
Power consumption, maximum	60 W
Dimensions and weights	
Width x depth x height	360 x 300 x 220 mm (approx. 14" x 12" x 9")
Weight	15 kg (35 lb.)
Mounting	
Installation on	Post, pipe or wall
Distance from wall or next chromatograph	300 mm (12")
Distance from ceiling or floor	200 mm (8")
Electromagnetic compatibility	
Noise suppression	According to CISPR 11 / EN 55011 / DIN VDE 0875 Limit class B
EMC immunity	According to IEC 60801/ DIN VDE 0843
Conducted interferences on AC supply lines	
• According to Part 4 (burst)	2 kV
• According to Part 5 (ms pulses), line against line	1 kV
• According to Part 5 (ms pulses), line against ground	2 kV
Conducted interferences on signal lines	
• According to Part 4 (burst)	1 kV
Immunity to static discharge	
• According to Part 2 (ESD)	8 kV
Immunity to fields	
• According to Part 3 and Part 6	10 V/m
Safety	
Electrical safety	IEC 61010 / DIN VDE 0411
Explosion protection	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

Oven	
Number/type	1 / isothermal
Purging with N_2	Possible
Dimensions (D x H)	160 x 10 mm
Max. heating power	35 VA
Temperature range	60 … 165 °C
Temperature stability	± 0.1 K (60 ... 165 °C)
Temperature accuracy	± 3 K (60 ... 165 °C)
Retention time variations per 10 °C change in ambient temperature	Approx. 0.3 %
Warm-up period from 30 … 100 °C	10 minutes
Columns and gases	
Column type	Capillary columns 0.15 ... 0.25 mm $\varnothing_{internal}$
Separating column switching	Multidimensional chromatography with backflushing and cut in live system
Multifunctional diaphragm valve	For injection and backflushing
Gas connections	Swagelok 1/8"
Pressure regulators	Max. 4 single-channel electronic pressure regulators
Solenoid valves for control of diaphragm valve	2 NC contacts, 2 NO contacts
Carrier gas	He (C09/C01), Ar (C01) **Notice:** Helium or Argon is used as the carrier gas when measuring with the analysis gas C01. 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	Not required
Sample and injection	
Sample streams	3
Calibration sample streams	1
Phase	Gaseous
Permissible sample pressure	10 … 60 kPa above atmospheric pressure NOTICE: Sample must not contain ethine (acetylene).
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
• Controller	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	100/150 s
Ambient temperature influence	Negligible
Influence of vibrations	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. CO_2, 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

Selection and ordering data	Order No.
SITRANS CV process gas chromatograph Basic unit (incl. application module) mounted on mounting bracket Explosion-proof, for Zone 1 Power supply 24 V DC For 3 sample streams + 1 calibration stream For ambient temperatures from -20 ... +55 °C Stand-alone communication via 1 RS 485, RS 232 interface (MODBUS RTU, ASCII) For post, pipe or wall mounting Includes CV Control operating software (English)	**7KQ3105-** ■
Applications	
For standard calorific value analysis (N_2, CO_2, C1-C5, C6+), certified in conjunction with GWK-CHRPA-CV-CER-1	**0**
For extended calorific value analysis with oxygen (N_2, CO_2, O_2, C1-C5, C6+)	**1**
For calorific value analysis with biomethane (N_2, H_2, CO_2, O_2, C1-C4)	**2**
Additional versions	**Order code**
Add "-Z" to Order No. and specify order code	
Russian configuration	
Russian configuration for extended calorific value analysis	**A01**
Extended measuring range in combination with position 8_0 and position 8_1	
N_2, $C0_2$, C1-C5, C6, C7 (+)	**B02**
N_2, $C0_2$, C1-C5, C6, C7, C8, C9 (+)	
Acceptance and customer information (in agreement with application laboratory)	
Factory acceptance, 1 day	**D01**
Factory acceptance (performance record), 1 day	**D02**
Factory acceptance, every additional day	**D03**
Proof of repeatability	
Repeatability up to 8 h	**E01**
Repeatability up to 24 h	**E02**
Repeatability up to 48 h	**E03**

Selection and ordering data	Order No.
Analog data transmission and serial interface External module for generation of analog and serial interfaces	**7KQ2160-** ■■■
Analog values via external unit (standard package)	
2 analog values	**0**
4 analog values	**1**
8 analog values	**2**
16 analog values[1)]	**3**
20 analog values[1)]	**4**
MODBUS multiplexer	
Without multiplexer	**A**
Without CE certificate	**B**
With CE certificate	**C**
Enclosure	
Without protective casing	**A**
With protective casing	**B**

[1)] On request

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 two serial interfaces. One RS 485 / RS 232 connection for Modbus communication (RTU / ASCII). Modbus mapping can be flexibly used (see manual for more information). SITRANS CV is operated via the second interface Ethernet (TCP/IP).

Other serial and analog (4 to 20 mA) interfaces are available as an option; these can be ordered as a supplementary solution package.

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.

CVControl 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 original master setup as the standard method, other country or user-specific method setups are available. The performance record ex works contains the analysis check, including a repeatability record (4h test).

The standard method (original master setup) is installed in the chromatograph, and four CD-ROMs are supplied with the following:

- 2 CDs SITRANS CV Software (including manuals and CVControl Operating Manual)
- 1 CD Country-specific partial setups
- 1 CD Parameter backup for SITRANS CV (including documentation for the individual module with TCD bridge voltages and EPC pressures, as well as module-specific hardware setups)

Order No. Pos. 8_0: Applications – Standard calorific value analysis - Certified in conjunction with GWK-CHRPA-CV-CER-1

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 4 and the criteria explained in the subsequent text apply to the individual components in Table 1 and their physical variables.

Calculation of the calorimetric variables is based on GOST, AGA 8 and ISO 6976-95 with the last-named as the default. The reference states for the combustion and for the gas volume that must be specified for calculation purposes are preset to the default state (T_b= 25 °C, T_n = 0 °C) and can be easily changed to other reference states during commissioning using the operating software (T_b = operating temperature, T_n = standard temperature).

The CVControl software provides the energy units BTU/ft^3, KWh/m^3 and MJ/m^3.

Order 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 (Order 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 5):

Component	Pos. 8_0 (mol%)	Pos. 8_1 (mol%)
Oxygen		0.5
Nitrogen	4	4
Carbon dioxide	1.5	1.5
Methane	88.9	88.4
Ethane	4	4
Propane	1	1
Isobutane	0.2	0.2
n-butane	0.2	0.2
Neopentane	0.05	0.05
Isopentane	0.05	0.05
n-pentane	0.05	0.05
n-hexane	0.05	0.05

Table 6: 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.

Order 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.

A01 – SITRANS CV for calorific value analysis

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.

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:

Required components	Calibration gas for C6 and C7(+) measurement (mol%)	Calibration gas for C6 and C9(+) measurement (mol%)
Nitrogen	4.00	4.00
Carbon dioxide	1.50	1.50
Methane	89.00	89.00
Ethane	4.00	4.00
Propane	1.00	1.00
Isobutane	0.20	0.20
n-butane	0.20	0.20
Neopentane	0.10	0.10
Isopentane	0.05	0.05
n-pentane	0.05	0.05
n-hexane	0.05	0.05
n-heptane	0.05	0.05
n-octane		0.05
n-nonane		0.05

Table 7: 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 proof 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 8 "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 Table 1
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 Auto-optimization of method	The two functions are explained theoretically and practically during presentation of CVControl.
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 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 9: "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.

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

Table 9: Recommended calibration gases for linearity test during acceptance

The calibration gases have the following uncertainties:

Proportions of component materials (Mol.%)	Uncertainty (or smaller)
0.1 ... 0.25	± 5.00 %
0.25 ... 1	± 1.00 %
1 ... 10	± 0.50 %
10 ... 100	± 0.20 %

Table 10: 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

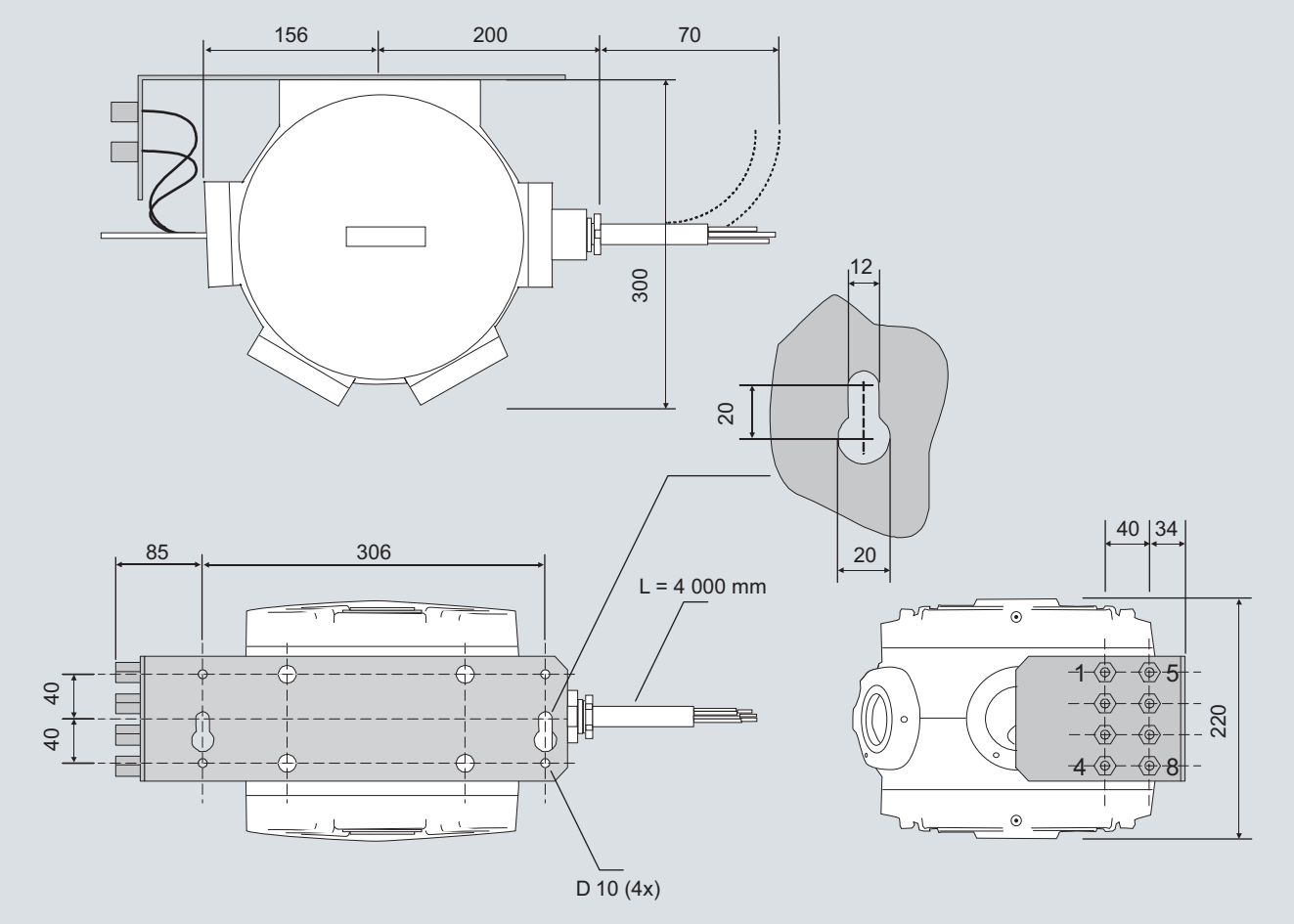
(only applicable together with 0-4)

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.

Dimensional drawings



SITRANS CV, dimensions in mm

Notes