Overview

The CALOMAT 6 gas analyzer is primarily used for quantitative determination of H_2 or He in digital or quasi-digital non-corrosive gas mixtures.

Concentrations of other gases can also be measured if their thermal conductivities differ significantly from the residual gases like Ar, CO_2, CH_4, NH_3.

Benefits

- Small T_{90} time due to micromechanical-produced Si sensor
- Universally applicable hardware basis, high measuring range dynamics (e.g. 0 to 1 %, 0 to 100 %, 95 to 100 % H_2)
- Integrated correction of cross-interference, no external calculation required
- Open interface architecture (RS 485, RS 232, PROFIBUS)
- SIPROM GA network for maintenance and service information (option)
- Electronics and physics: gas-tight separation, purgeable, IP65, long service life even in harsh environments
- Ex(p) for Zones 1 and 2 (in accordance with 94/9/EC (ATEX 2G and ATEX 3G), and Class I Div 2 (CSA) Ex(n)

Application

Fields of application

- Pure gas monitoring (0 to 1 % H_2 in Ar)
- Protective gas monitoring (0 to 2 % He in N_2)
- Hydroargon gas monitoring (0 to 25 % H_2 in Ar)
- Forming gas monitoring (0 to 25 % H_2 in N_2)
- Gas production:
  - 0 to 2 % He in N_2
  - 0 to 10 % Ar in O_2
- Chemical applications:
  - 0 to 2 % H_2 in NH_3
  - 50 to 70 % H_2 in N_2
- Wood gasification (0 to 30 % H_2 in $CO/CO_2/CH_4$)
- Blast furnace gas (0 to 5 % H_2 in $CO/CO_2/CH_4/N_2$)
- Bessemer converter gas (0 to 20 % H_2 in CO/CO_2)
- Monitoring equipment for hydrogen-cooled turbo-alternators:
  - 0 to 100 % CO_2/Ar in air
  - 0 to 100 % H_2 in CO_2/Ar
  - 80 to 100 % H_2 in air
- Versions for the analysis of flammable and non-flammable gases or vapors for use in hazardous areas (Zone 1 and Zone 2)

Special versions

Special applications

In addition to the standard combinations, special applications are also available upon request (e.g. higher sample gas pressure up to 2 000 hPa absolute).

Design

19" rack unit

- With 4 HU for installation
  - In hinged frame
  - In cabinets with or without telescope rails
- Front plate can be swung down for servicing purposes (laptop connection)
- Internal gas paths: stainless steel pipe (mat. no. 1.4571)
- Gas connections for sample gas inlet and outlet and for purging gas: fittings, pipe diameter of 6 mm or ¼"

Field device

- Two-door enclosure (IP65) with gas-tight separation of analyzer and electronics sections
- Individually purgeable enclosure halves
- Stainless steel gas path and stubs (mat. no. 1.4571)
- Purging gas connections: pipe diameter 10 mm or 3/8"
- Gas connections for sample gas inlet and outlet: clamping ring connection for a pipe diameter of 6 mm or ¼"

Display and control panel

- Large LCD panel for simultaneous display of:
  - Measured value (digital and analog displays)
  - Status bar
  - Measuring ranges
- Contrast of LCD panel adjustable using menu
- Permanent LED backlighting
- Washable membrane keyboard with five softkeys
- Menu-driven operation for parameterization, test functions, adjustment
- User help in plain text
- Graphic display of concentration trend; programmable time intervals
- Bilingual operating software German/English, English/Spanish, French/English, Spanish/English, Italian/English

Input and outputs

- One analog output per medium (from 0, 2, 4 to 20 mA; NAMUR parameterizable)
- Two analog inputs configurable (e.g. correction of cross-interference or external pressure sensor)
- Six digital inputs freely configurable (e.g. for measurement range switchover, processing of external signals from sample preparation)
- Six relay outputs, freely configurable (e.g. failure, maintenance demanded, threshold alarm, external magnetic valves)
- Expansion by eight additional digital inputs and eight additional relay outputs each (e.g. for autocalibration with up to four calibration gases)

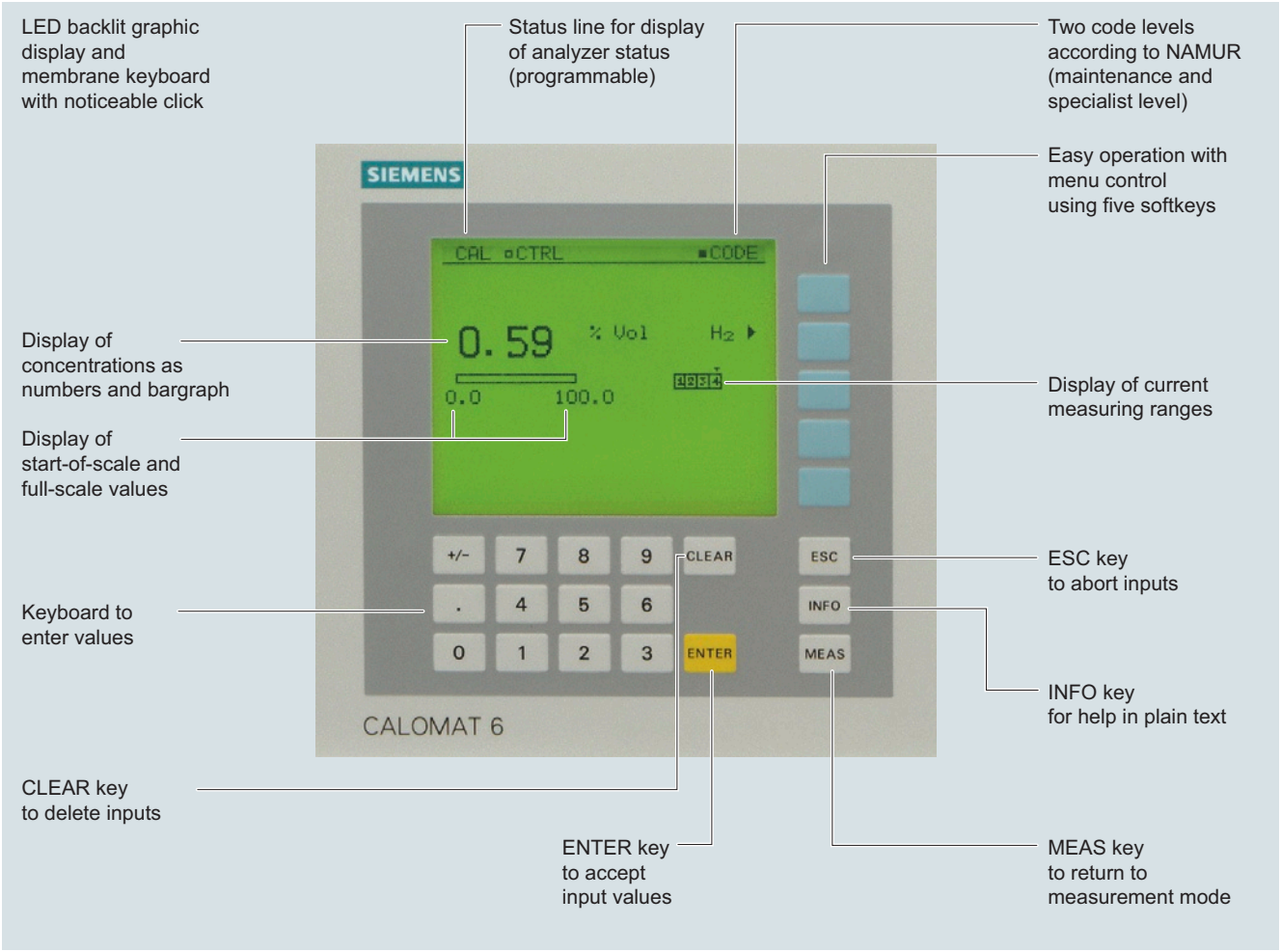
Communication

RS 485 present in basic unit (connection from the rear; for the slide-in module also behind the front plate).

Options

- RS 485/RS 232 converter
- RS 485/Ethernet converter
- RS 485/USB converter
- Connection to networks via PROFIBUS DP/PA interface
- SIPROM GA software as the service and maintenance tool

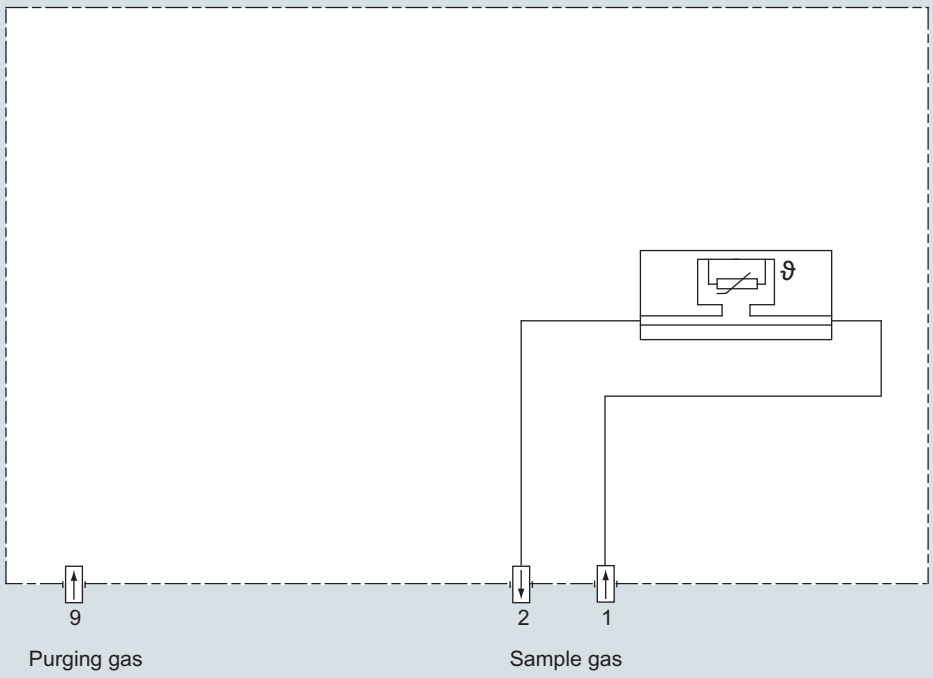
General information



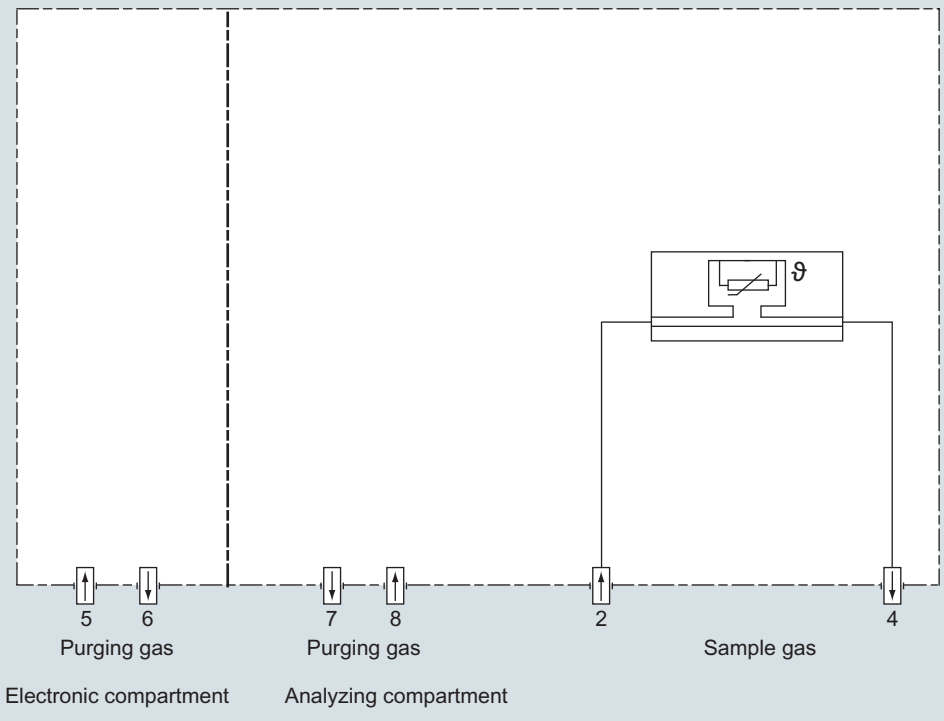
CALOMAT 6, membrane keyboard and graphic display

Designs – parts wetted by sample gas

Gas path		19" rack unit	Field device	Field device Ex
With pipes	Bushing	Stainless steel, mat. no. 1.4571		
	Pipe	Stainless steel, mat. no. 1.4571		
	Sample cell body	Stainless steel, mat. no. 1.4571		
	O-rings	FFKM-Chemraz		
	Sensor	Si, SiO_xN_y, AU, epoxy resin, glass		
	Tightness	Leakage < 1 µl/s		



CALOMAT 6, 19" rack unit, gas path



CALOMAT 6, field device, gas path

Function

Principle of operation

The measuring principle is based on the different thermal conductivity of gases.

The CALOMAT 6 works with a micromechanically produced Si chip whose measuring membrane is equipped with thin-film resistors.

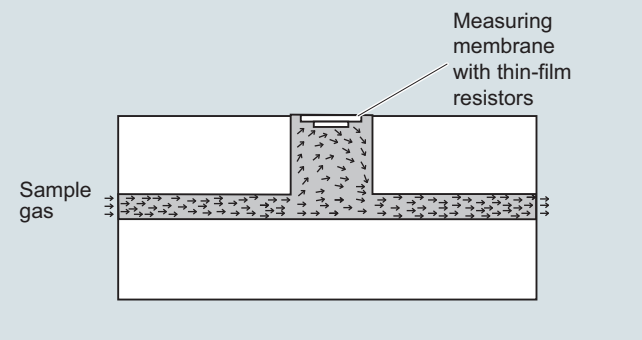
The resistors are kept at a constant temperature. This requires an current intensity depending on the thermal conductivity of the sample gas. This "raw value" is processed further electronically to calculate the gas concentration.

The sensor is located in a thermostatically-controlled stainless steel enclosure in order to prevent the influence of changes in ambient temperature.

To prevent the influence of changes in flow, the sensor is positioned in a bore located to the side of the main flow.

Note

The sample gases must be fed into the analyzers free of dust. Condensation (dew point sample gas < ambient temperature) is to be avoided in the measurement chambers. Therefore, the use of gas modified for the measuring tasks is necessary in most application cases.



CALOMAT, principle of operation

Essential characteristics

- Four freely parameterizable measuring ranges, also with suppressed zero point, all measuring ranges linear
- Smallest measuring spans up to 1 % H_2 (with disabled zero point: 95 to 100 % H_2) possible
- Measuring range identification
- Galvanically isolated measured-value output 0/2/4 to 20 mA (also inverted)
- Autoranging or manual measurement range switchover possible; remote switching is also possible
- Storage of measured values possible during adjustments
- Wide range of selectable time constants (static/dynamic noise suppression); i.e. the response time of the analyzer can be matched to the respective measuring task
- Short response time
- Low long-term drift
- Measuring point switchover for up to 6 measuring points (programmable)
- Measuring range identification
- Measuring point identification
- External pressure sensor can be connected – for the correction of sample gas fluctuations
- Automatic range calibration can be parameterized
- Operation based on the NAMUR recommendation
- Two control levels with their own authorization codes for the prevention of accidental and unauthorized operator interventions
- Simple handling using a numerical membrane keyboard and operator prompting
- Customer-specific analyzer options such as:
  - Customer acceptance
  - TAG labels
  - Drift recording
  - Clean for O_2 service

Measuring spans

The smallest and largest possible spans depend on both the measured component (type of gas) and the respective application.

The smallest possible spans listed below refer to N_2 as the residual gas. With other gases which have a larger/smaller thermal conductivity than N_2, the smallest possible span is also larger/smaller.

Component	Smallest possible span
H_2	0 ... 1 % (95 ... 100 %)
He	0 ... 2 %
Ar	0 ... 10 %
CO_2	0 ... 20 %
CH_4	0 ... 15 %
H_2 in blast furnace gas	0 ... 10 %
H_2 in converter gas	0 ... 20 %
H_2 with wood gasification	0 ... 30 %

Influence of interfering gases

Knowledge of the sample gas composition is necessary to determine the influence of residual gases with several interfering components.

The following table lists the zero offsets expressed in % H_2 resulting from 10 % residual gas (interfering gas) in each case.

Component	Zero offset
Ar	-1.28 %
CH_4	+1.59 %
C_2H_6 (non-linear response)	+0.04 %
C_3H_8	-0.80 %
CO	-0.11 %
CO_2	-1.07 %
He	+6.51 %
H_2O (non-linear response)	+1.58 %
NH_3 (non-linear response)	+1.3 %
O_2	+0.18 %
SF_6	-2.47 %
SO_2	-1.34 %
100 % air (dry)	+0.27 %

For residual gas concentrations differing from 10 %, the corresponding multiple of the associated value in the table provides an acceptable approximation. This is valid for for residual gas concentrations up to 25 % (dependent on type of gas).

The thermal conductivity of most gas mixtures has a non-linear response. Even ambiguous results, such as e.g. with NH_3/N_2 mixtures, can occur within a specific concentration range.

In addition to a zero offset, it should also be noted that the gradient of the characteristic is influenced by the residual gas. However, this effect is negligible for most gases.

In case of correction of the influence of interfering gases with additional analyzers (ULTRAMAT 6/ULTRAMAT 23), the resulting measuring error can – depending on the application – amount up to 5 % of the smallest measuring range of the respective application.

Example of correction of cross-interference

Specification for the interface cable

Surge impedance	100 ... 300 Ω, with a measuring frequency of > 100 kHz
Cable capacitance	Typ. < 60 pF/m
Core cross-section	> 0.22 mm^2, corresponds to AWG 23
Cable type	Twisted pair, 1 x 2 conductors of cable section
Signal attenuation	Max. 9 dB over the whole length
Shielding	Copper braided shield or braided shield and foil shield
Connection	Pin 3 and pin 8

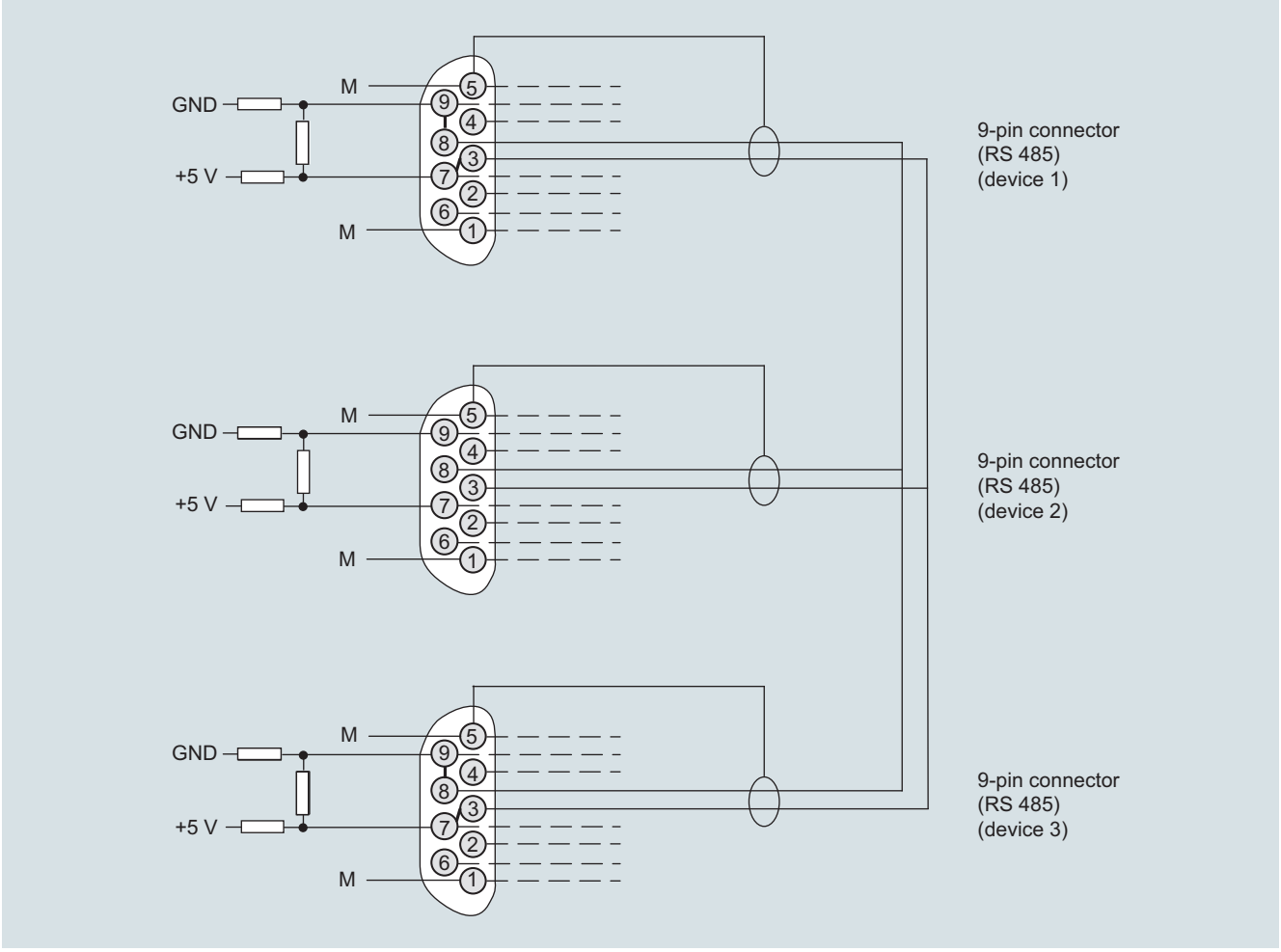
Bus terminating resistors

Pins 3-7 and 8-9 of the first and last connectors of a bus cable must be bridged (see graphic).

Note

It is advisable to install a repeater on the device side in the case of a cable length of more than 500 m or with high interferences.

Up to four components can be corrected via the ELAN bus, correction of cross-interference can be carried out for one or two components via the analog input.



Bus cable with plug connections, example

Technical specifications

General information	Based on DIN EN 61207 / IEC 1207. All data based on digital gas mixture H_2 in N_2
Measuring ranges	4, internally and externally switchable; automatic measuring range switchover also possible
Largest possible measuring span	100 vol.% H_2 (for smallest measuring span, see "Function")
Measuring ranges with suppressed zero point	Any zero point within 0 ... 100 vol.% can be implemented, smallest possible measuring span: 5% H_2
Operating position	Front wall, vertical
Conformity	CE mark in accordance with EN 61326/A1 and EN 61010/1
Design, enclosure	
Degree of protection	IP20 according to EN 60529
Weight	Approx. 10 kg
Electrical characteristics	
EMC interference immunity (electromagnetic compatibility)	In accordance with standard requirements of NAMUR NE21 (08/98)
All signal lines must be shielded. Measured value deviations of up to 4% of the smallest measuring range may occur in ranges with strong electromagnetic interference.	
Electrical safety	In accordance with EN 61010-1; overvoltage category II
Auxiliary power (see nameplate)	100 V -10% ... 120 V +10% AC, 48 ... 63 Hz or 200 V -10% ... 240 V +10% AC, 48 ... 63 Hz
Power consumption	Approx. 20 VA
Fuse values	100 to 120 V: 1.0T/250 200 ... 240 V: 0.63 T/250
Gas inlet conditions	
Sample gas pressure	800 ... 1 100 hPa (absolute)
Sample gas flow	30 ... 90 l/h (0.5 ... 1.5 l/min)
Sample gas temperature	Min. 0 to max. 50 °C, but above the dew point
Temperature of the measuring cell	Approx. 60 °C
Sample gas humidity	< 90% relative humidity
Dynamic response	
Warm-up period	< 30 min (the technical specification will be met after 2 hours)
Delayed display (T_{90})	< 5 s
Damping (electrical time constant)	0 ... 100 s, configurable
Dead time (purging time of the gas path in the unit at 1 l/min)	Approx. 0.5 s

Measuring response	Based on sample gas pressure 1 013 hPa absolute, 0.5 l/min sample gas flow and 25 °C ambient temperature
Output signal fluctuation	< ± 0.75% of the smallest possible measuring range according to rating plate, with electronic damping constant of 1 s (σ = 0.25%)
Zero point drift	< ± 1%/week of the smallest possible measuring span according to rating plate
Measured-value drift	< ± 1%/week of the smallest possible measuring span according to rating plate
Repeatability	< 1% of the current measuring range
Detection limit	1% of the current measuring range
Linearity error	< ± 1% of the current measuring range
Influencing variables	Based on sample gas pressure 1 013 hPa absolute, 0.5 l/min sample gas flow and 25 °C ambient temperature
Ambient temperature	< 1%/10 K referred to smallest possible measuring span according to rating plate
Accompanying gases	Deviation from zero point (for influence of interfering gas see paragraph titled "Interference influences")
Sample gas flow	< 0.2% of the smallest possible span according to rating plate with a change in flow of 0.1 l/min within the permissible flow range
Sample gas pressure	< 1% of the current measuring range with a pressure change of 100 hPa
Auxiliary power	< 0.1% of the current measuring range with rated voltage ± 10%
Electrical inputs and outputs	
Analog output	0/2/4 ... 20 mA, floating; load max. 750 Ω
Relay outputs	6, with changeover contacts, freely parameterizable, e.g. for measuring range identification; load: 24 V AC/DC/ 1 A, isolated
Analog inputs	2, dimensioned for 0/2/4 … 20 mA for external pressure sensor and correction of cross-interference
Digital inputs	6, designed for 24 V, isolated, freely parameterizable, e.g. for measurement range switchover
Serial interface	RS 485
Options	AUTOCAL function each with 8 additional digital inputs and relay outputs, also with PROFIBUS PA or PROFIBUS DP
Climatic conditions	
Permissible ambient temperature	-30 … +70 °C during storage and transportation, 5 … 45 °C during operation
Permissible humidity (dew point must not be fallen below)	< 90% relative humidity as annual average, during storage and transportation

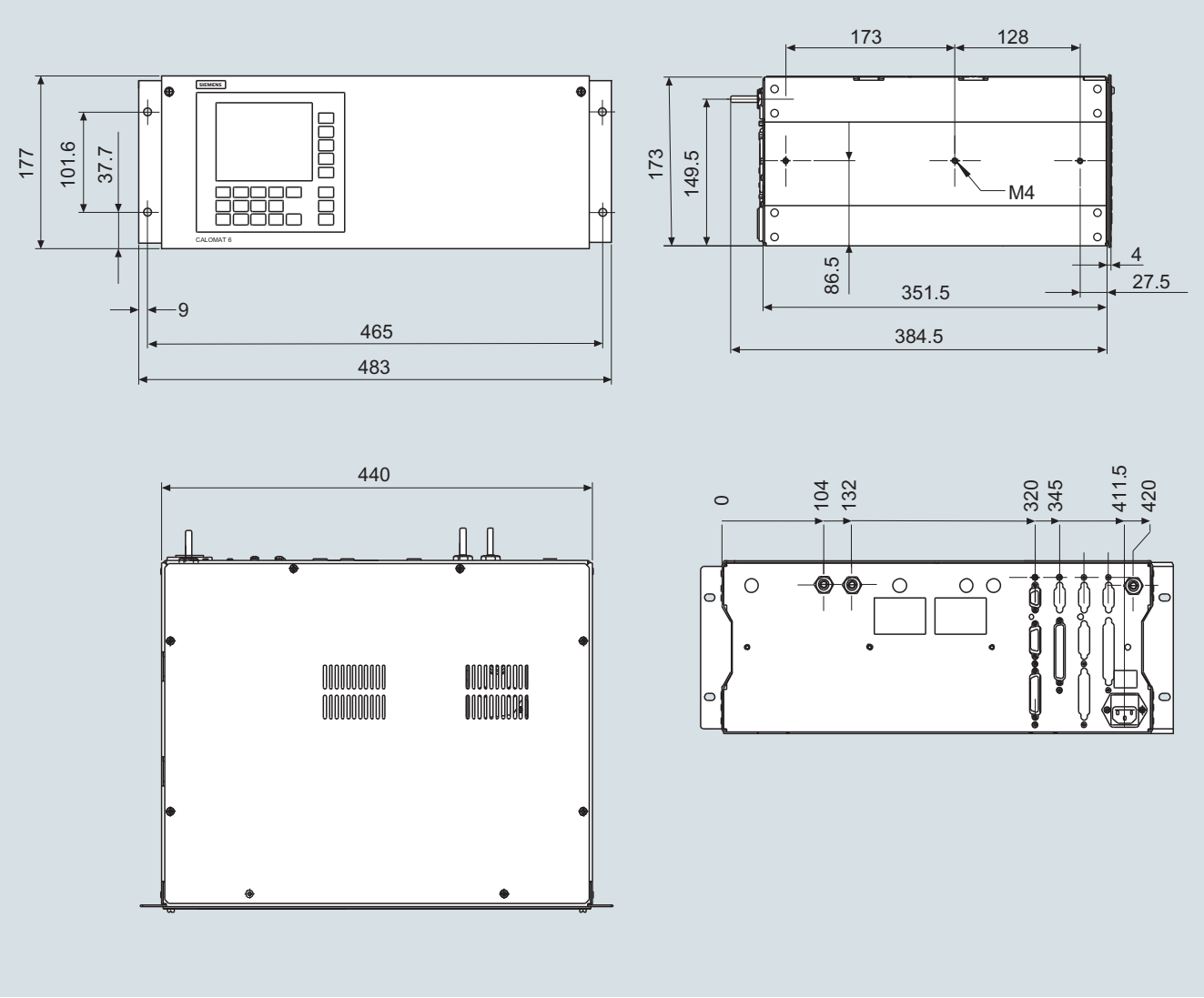
Selection and ordering data		Article No.	Cannot be combined
CALOMAT 6 gas analyzer 19" rack unit for installation in cabinets		↗ **7MB2521-** ■■■0■ - ■A■■	
↗ Click on the Article No. for the online configuration in the PIA Life Cycle Portal.			
Connections for sample gas			
Pipe with 6 mm outer diameter		0	
Pipe with 1/4" outer diameter		1	
Measured component	Smallest/largest measuring range		
H_2 in N_2	0 ... 1/100 %	A A	
H_2 in N_2 (blast furnace gas measurement)[1]	0 ... 5/100 %	A W	
H_2 in N_2 (converter measurement)[1]	0 ... 5/100 %	A X	
H_2 in N_2 (wood gasification)[1]	0 ... 5/100 %	A Y	
H_2 in Ar	0 ... 1/100 %	A B	
H_2 in NH_3	0 ... 1/100 %	A C	
He in N_2	0 ... 2/100 %	B A	
He in Ar	0 ... 2/100 %	B B	
He in H_2	0 ... 10/80 %	B C	
Ar in N_2	0 ... 10/100 %	C A	
Ar in O_2	0 ... 10/100 %	C B	
CO_2 in N_2	0 ... 20/100 %	D A	
CH_4 in Ar	0 ... 15/100 %	E A	
NH_3 in N_2	0 ... 10/30 %	F A	
H_2 monitoring (turbo generators)		G A	GA
• CO_2 in air	0 ... 100 %		
• H_2 in CO_2	0 ... 100 %		
• H_2 in air	80 ... 100 %		
Add-on electronics			
Without		0	
AUTOCAL function			
• With 8 additional digital inputs and outputs		1	
• With 8 additional digital inputs/outputs and PROFIBUS PA interface		6	6
• With 8 additional digital inputs/outputs and PROFIBUS DP interface		7	7
Power supply			
100 ... 120 V AC, 48 ... 63 Hz		0	
200 ... 240 V AC, 48 ... 63 Hz		1	
Explosion protection			
Without		A	
Certificate: ATEX II 3G, flammable and non-flammable gases		B	
FM/CSA certificate – Class I Div 2		D	
Language (supplied documentation, software)			
German		0	
English		1	
French		2	
Spanish		3	
Italian		4	

[1] Ready to enter external correction of cross-interferences for CO, CO_2 and CH_4 (CH_4 only for blast furnace gas and wood gasification).

Selection and ordering data

Additional versions	**Order code**
Add "-Z" to Article No. and specify Order codes.	
Telescopic rails (2 units)	**A31**
TAG labels (specific lettering based on customer information)	**B03**
Clean for O_2 service (specially cleaned gas path)	**Y02**
Measuring range indication in plain text, if different from the standard setting	**Y11**
Special setting (only in conjunction with an application no.)	**Y12**
Accessories	**Article No.**
RS 485/Ethernet converter	**A5E00852383**
RS 485/RS 232 converter	**C79451-Z1589-U1**
RS 485/USB converter	**A5E00852382**
AUTOCAL function with 8 digital inputs/outputs	**C79451-A3480-D511**
AUTOCAL function with 8 digital inputs/outputs and PROFIBUS PA	**A5E00057307**
AUTOCAL function with 8 digital inputs/outputs and PROFIBUS DP	**A5E00057312**
Set of Torx screwdrivers	**A5E34821625**

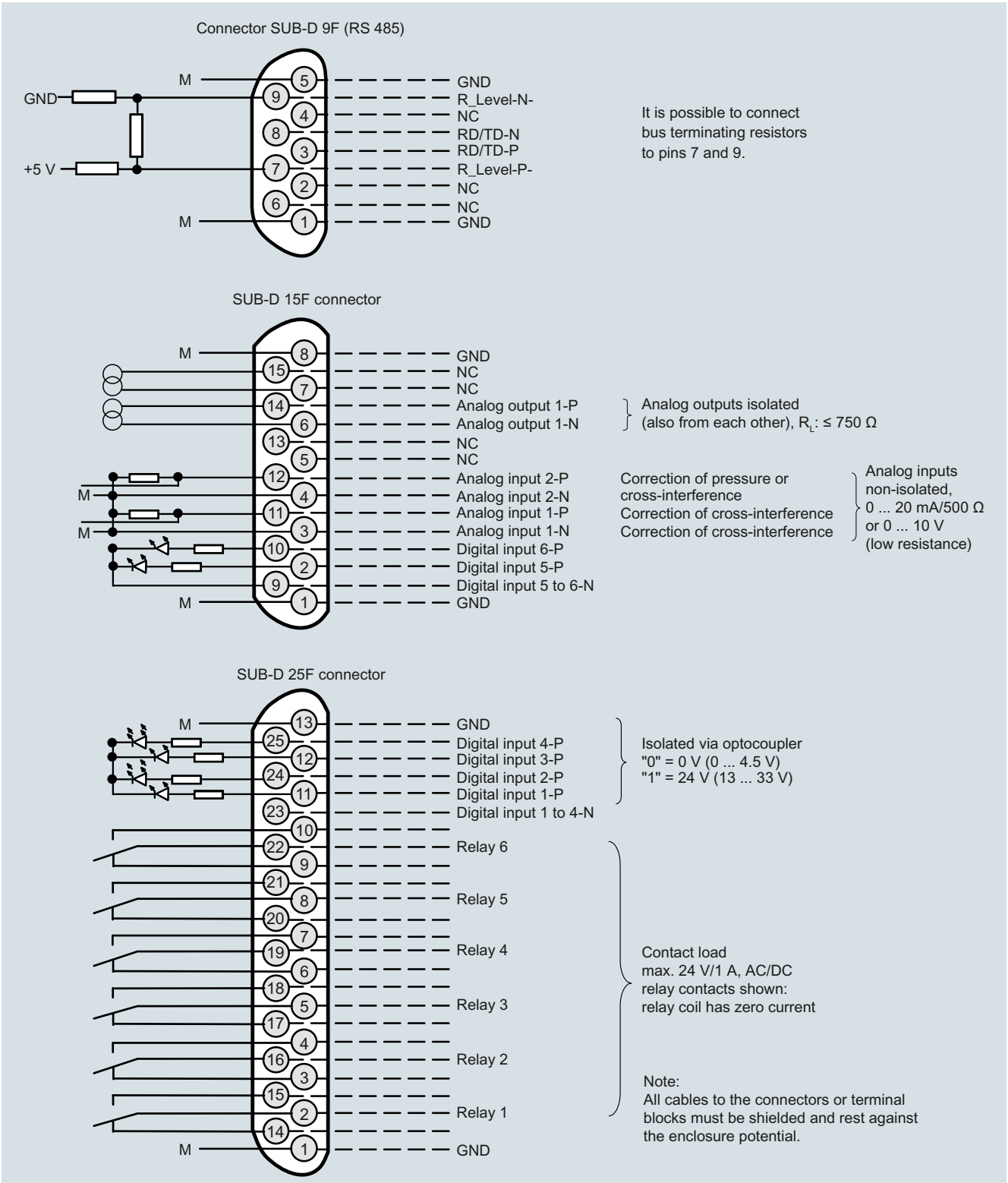
Dimensional drawings



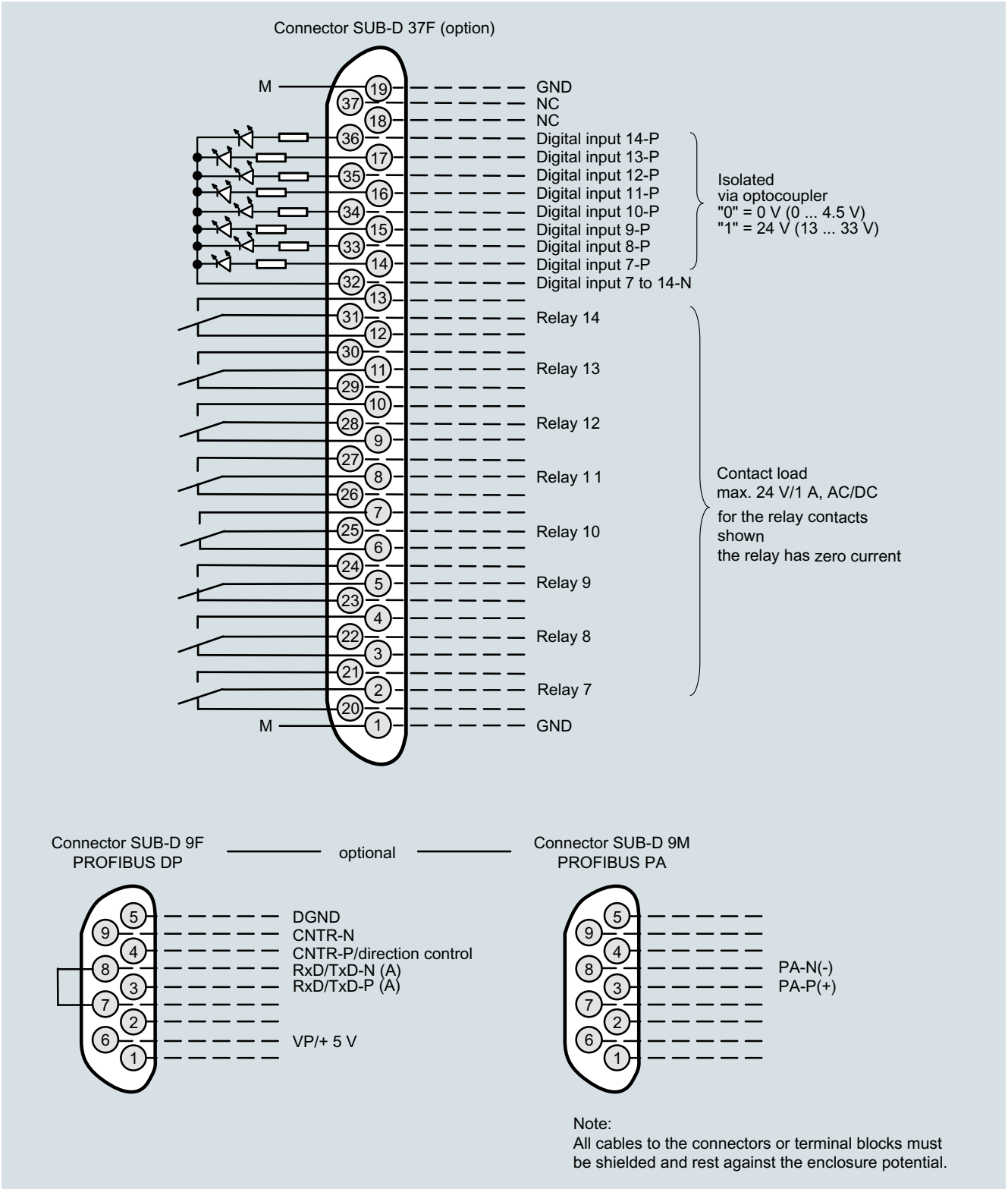
CALOMAT 6, 19" unit, dimensions in mm

Circuit diagrams

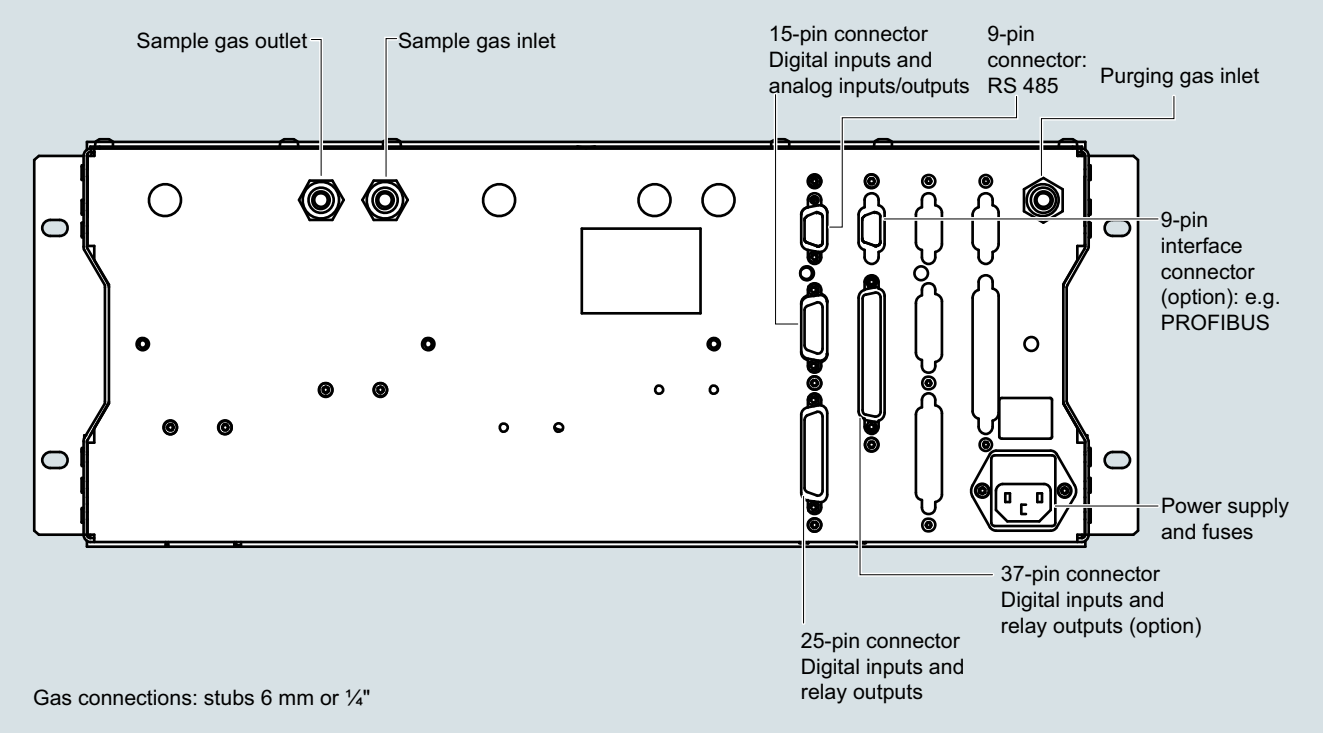
Pin assignment (electrical and gas connections)



CALOMAT 6, 19" unit, pin assignment



CALOMAT 6, 19" unit, pin assignment of AUTOCAL board and PROFIBUS connectors



CALOMAT 6, 19" unit, gas and electrical connections