CALOMAT 6
Thermal Conductivity Gas Analyzer

Siemens Extract PA 10 · November 2002

General

Application

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

Concentrations of other gases can also be measured if their thermal conductivities differ significantly from the residual gases.

The measuring principle is based on the different thermal conductivity of gases. The **CALOMAT 6** operates with a micro-mechanically manufactured Si sensor which is particularly characterized by a short T_{90} time.

Special applications

Besides the standard combinations, special applications concerning the measuring components and residual gases are available on request.

Application examples

- Pure gas monitoring (0...1 % H_2 in Ar)
- Inert gas monitoring (0...2 % H_2 in N_2)
- Hydroargon gas monitoring (0...25 % H_2 in Ar)
- Forming gas monitoring (0...25 % H_2 in N_2)
- Gas production:
  - 0...2 % He in N_2
  - 0...10 % Ar in O_2
- Chemical applications:
  - 0...2 % H_2 in NH_3
  - 50...70 % H_2 in N_2
- Wood gasification (0...30 % H_2 in $CO/CO_2/CH_4$)
- Blast furnace gas (0...5 % H_2 in $CO/CO_2/CH_4/N_2$)
- Bessemer converter gas (0...20 % H_2 in CO/CO_2)
- Monitoring equipment for hydrogen-cooled turbo-alternators:
  - 0...100 % CO_2/Ar in air
  - 0...100 % H_2 in CO_2/Ar
  - 80...100 % H_2 in air
- Version to analyze flammable and non-flammable gases or vapors for use in hazardous areas (zone 1 and zone 2). (Use in hazardous areas of zone 0 is not possible.)

Essential characteristics

- Four freely-progammable measuring ranges, also with zero offset, all measuring ranges linear
- Smallest spans up to 1% H_2 (with suppressed zero: 95 to 100 % H_2) possible
- Electrically isolated analog output 0/2/4 to 20 mA
- Autoranging or manual range switching possible; remote switching is also possible
- Measuring point selection for up to 6 measuring points (can be parameterized)
- Measuring range identification
- Measuring point identification
- Storage of measured values possible during calibration
- Time constants selectable within wide limits (static/dynamic noise suppression); i.e. the response time of the analyzer can be matched to the respective application
- Simple handling using menu-based operation (interactive mode) according to NAMUR Recommendation
- Short response time
- Low long-term drift
- Two operation levels with separate access code to prevent unintentional and unauthorized inputs
- External pressure sensor for correction of pressure variations in sample gas
- Automatic range calibration can be parameterized
- Customer-specific analyzer options such as e.g.:
  - Customer acceptance
  - Tag labels
  - Drift recording

Essential charac6teristics of the 19“ unit

- 19“ unit with 4 HU for installation
  - in swing frame
  - in cabinets, with or without slide rails
- Front panel for service can be hinged down (e.g. for laptop connection)
- Internal gas paths: pipe made of stainless steel
- Gas connections for sample gas input and output: pipe diameter 6 mm or 1/4"

Essential characteristics of the field unit

- Two-door housing with gas-tight separation of analyzer and electronics sections
- Sections can be purged separately
- Gas path and pipe couplings made of stainless steel (type No. 1.4571)
- Gas connections: coupling for pipe diameter 6 mm or 1/4"
- Purging gas connections: pipe diameter 10 mm or 3/8"
- Simple analyzer exchange since electric connections are easy to remove

Design

Display and control panel

- Large LCD panel for simultaneous display of:
  - Measured value (digital and analog displays)
  - Status line
  - Measuring ranges
- Contrast of LCD panel adjustable using menu
- Permanent LED backlighting
- Five-digit measured-value display (decimal point counts as a digit)
- Washable membrane keyboard/front panel
- Menu-based operation for configuration, test functions and calibration
- User help in plain text
- Graphic display of concentration trend; programmable time intervals
- Operating software in two languages:
  German/English, English/Spanish, French/English, Spanish/English, Italian/English.

Inputs and outputs

- One analog output
- Two analog inputs programmable, e.g. for correction of cross interferences or external pressure sensor
- Six binary inputs freely configurable, e.g. for range switching
- Six relay outputs freely configurable, e.g. for failure, maintenance request, limit alarm, external solenoid valves
- Extension with eight additional binary inputs and eight additional relay outputs for automatic calibration with up to four calibration gases

Communication

- RS 485 present in basic unit (connection at the rear, with 19“ unit also possibility of connection behind the front plate)

Options

- Converter to RS 232
- Converter to TCP/IP Ethernet
- Linking to networks via PROFIBUS-DP/-PA interface
- SIPROM GA software as service and maintenance tool

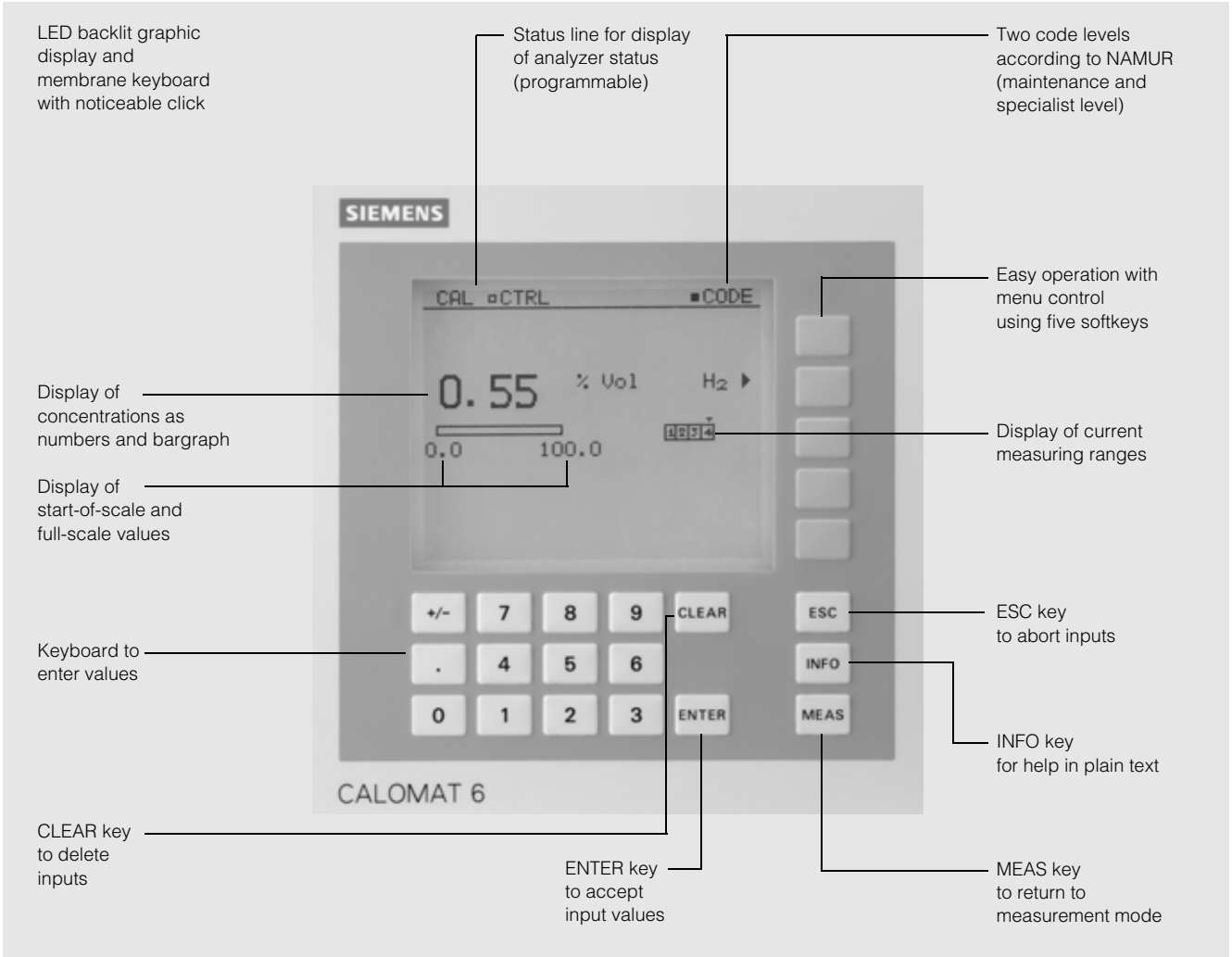


Fig. 1 CALOMAT 6, membrane keyboard and graphic display

Mode of operation, spans, interferences

Mode of operation

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

The CALOMAT 6 sensor is a micromechanical-made Si chip with a measuring membrane and thin-film resistors.

The resistors are adjusted on a constant temperature. This requires an current intensity depending on the sample gas thermal conductivity. Further this „coarse value“ is electronically processed and used to calculate the gas concentration.

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

To prevent the influences by the sample gas changes, the sensor is not placed in the main flow.

Note

The sample gases have to enter the analyzer dustfree. Avoid condensate in the sample cells. That is why the most measuring tasks require an appropriate gas preparation.

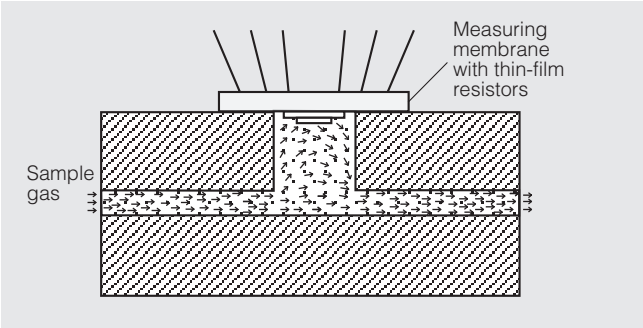


Fig. 2 CALOMAT 6, mode of operation

Spans

The smallest and largest spans which are possible depend on the measured component (type of gas) as well as 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.

	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 Bessemer 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)	-0.06 %
C_3H_8	-0.80 %
CO	-0.11 %
CO_2	-1.07 %
He	+6.51 %
N_2O	+1.08 %
NH_3 (non-linear response)	+0.71 %
O_2	-0.18 %
SF_6	-2.47 %
SO_2	-1.34 %
Air (dry)	+0.25 %

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

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 application.

Executions of the wetted parts

Gas path		19“ unit	Field unit	Field unit Ex
with pipes	Nipple	SS, type No. 1.4571		
	Pipe	SS, type No. 1.4571		
	Sample cell body	SS, type No. 1.4571		
	O-rings	FFKM - Chemraz		
	Sensor	Si, SiO_xN_y, AU, epoxy resin, glass		
	Tightness	leakage < 1 µl/s		

Communications facilities

The gas analyzers of series 6, ULTRAMAT 6, ULTRAMAT/OXYMAT 6, OXYMAT 6, OXYMAT 61 and CALOMAT 6, as well as the ULTRAMAT 23 offer the following communications facilities:

- Serial **RS 485** interface present as standard with internal communications bus (ELAN) which permits communication between the analyzers and – with multi-channel analyzers – from one channel to the other via the serial interface even without a PC for e.g. information on the process gas pressure and compensation of the influences of interfering gases.
- **SIPROM GA**, a software tool especially for servicing and maintenance tasks. All functions of the analyzers, whether an individual device or where several are networked together, can be remote controlled and monitored using SIPROM GA.
- **PROFIBUS-DP/-PA** is the leading field bus on the market. All Siemens gas analyzers are suitable for PROFIBUS when equipped with an optional plug-in card (retrofitting also possible) and satisfy the binding "Device profile for analyzers" defined by the **PNO** (PROFIBUS user organization). Central access to the analyzers in the system is possible using the **SIMATIC PDM** operator input software.

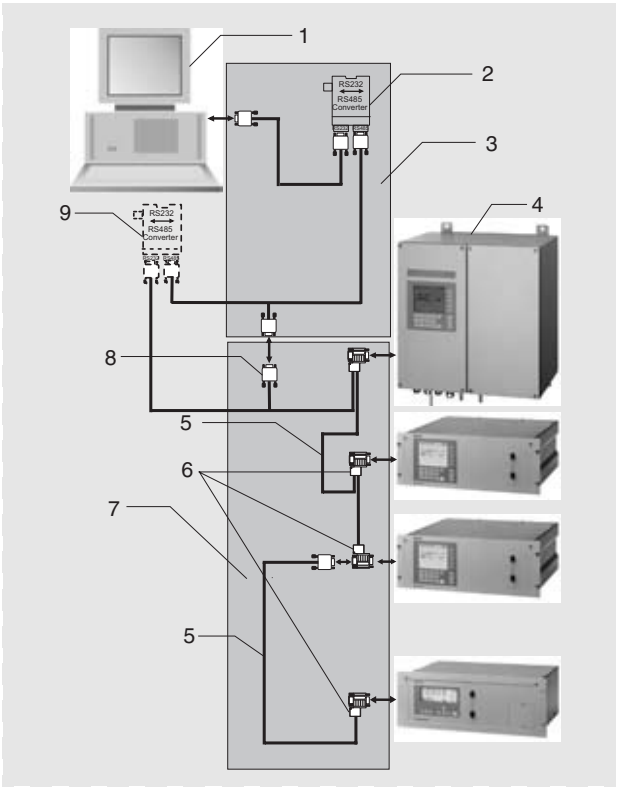


Fig. 3 Typical design of an RS 485 network

Item	Designation
1	Computer
2	RS 485/RS 232 converter with RS 232/RS 485 cable
3	RS 485 bus connector with jumper
4	Analyzers
5	RS 485 cable
6	RS 485 bus connector
7	RS 485 network
8	9-pin DSUB plug
9	Option: RS 485 repeater

Interface parameters

Level	RS 485
Baud rate	9600
Data bits	8
Stop bit	1
Start bit	1
Parity	None
No echo mode	

Ordering information	Order No.
Interface description (German)	**A5E000 54148**
RS 485/RS 232 converter	**C79451-Z1589-U1**
RS 485/Ethernet converter	**C79451-A3364-D61**
SIMATIC cable/bus cable	**6XV1 830-0EH10**
SIMATIC bus connector	**6ES7 972-0BB11-0XA0**
9-pin DSUB plug	**6ES7 972-0BB11-0XA0**
Repeater (see also Catalog CA 01 or IK PI)	**6ES7 972-0AA01-0XA0**

SIPROM GA

Application: communications software for remote maintenance and servicing of Siemens process gas analyzers; max. 12 analyzers with up to 4 components each. Networking of several gateways is possible when using the RS 485/Ethernet converter. The number of operatable analyzers is increased correspondingly.

Functions: display and saving of all analyzer data, remote operation of all analyzer functions, parameter and configuration settings; comprehensive diagnostics information, remote calibration; online help; cyclic saving of measured values and status on hard disk and exporting to commercially available application programs, downloading of new software.

Hardware requirements: PC/laptop; recommended with Pentium II 6 MB RAM, free COM port: RS 232 or RS 485, CD drive.

Software requirements: Windows 95 or NT 4 (SP6), Windows 2000 or Windows X-P.

Ordering information	Order No.
SIPROM GA software German/English selectable during installation, comprising 1 CD, with installation instructions, software product certificate and registration form	**S79610-B4014-A1**
Firmware retrofitting sets for older analyzers:	
ULTRAMAT 23 (prior to SW version 2.06) All languages	**C79451-A3494-S501**
ULTRAMAT 6 (prior to SW version 4.1)	
• German	**C79451-A3478-S501**
• English	**C79451-A3478-S502**
• French	**C79451-A3478-S503**
• Spanish	**C79451-A3478-S504**
• Italian	**C79451-A3478-S505**
OXYMAT 6 (prior to SW version 4.1)	
• German	**C79451-A3480-S501**
• English	**C79451-A3480-S502**
• French	**C79451-A3480-S503**
• Spanish	**C79451-A3480-S504**
• Italian	**C79451-A3480-S505**

PROFIBUS-DP/-PA

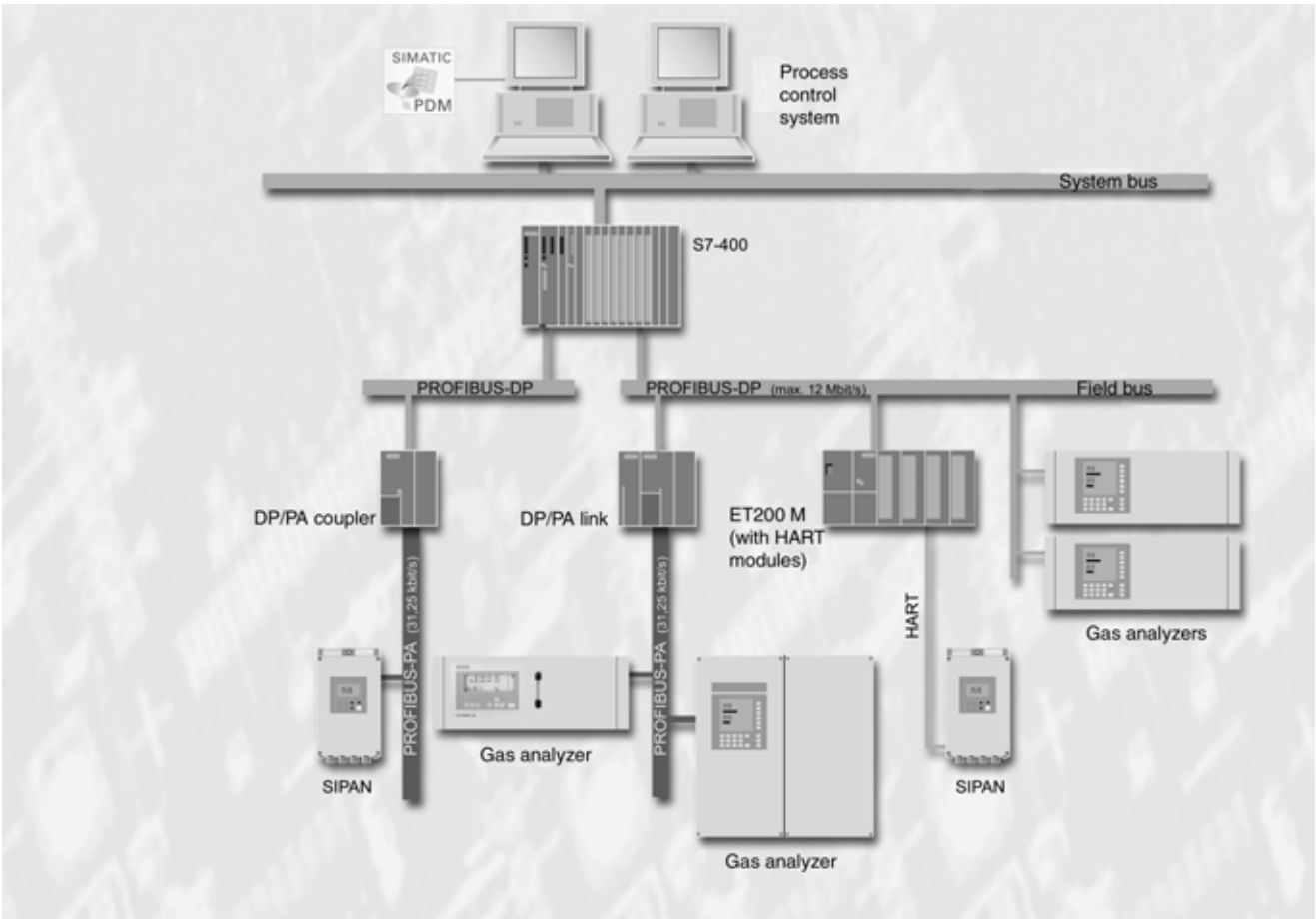


Fig. 4 Basic structure of a PROFIBUS system

The term "Field bus" describes a digital communications system with which distributed field devices in a plant are networked together via one single cable, and connected at the same time to programmable controllers or to a process control system. PROFIBUS is the leading field bus on the market. The **PROFIBUS-DP** version is widely used for production automation because of its high transmission rate for relatively small data quantities per device, whereas **PROFIBUS-PA** particularly takes into account the features required for process engineering, e.g. large data quantities and application in potentially explosive atmospheres.

User benefits can be found in the extremely high potentials for cost savings in all areas of the plant, covering configuring and commissioning, operation and maintenance, and up to later plant extensions.

Operation of the gas analyzers from a control system or separate PC is possible using the SIMATIC PDM (Process Device Manager) operator input tool which is software executing under Windows 95/98/NT and which can also be incorporated into the SIMATIC PCS 7 process control system. This permits clear display of both the incorporation of devices into the system and the complex parameter structure of the analyzers, permitting operation to be carried out simply by clicking.

The PROFIBUS user organization (PNO) is an independent international institution, and represents the interests of many vendors and users. In addition to services such as consultation, training and device certification, its prime task is the further development, standardization and promotion of the PROFIBUS technology. The definition of a binding functionality for a device class in a profile is a prerequisite for the uniform response of devices from different vendors, the so-called interoperability. The **profile for analyzers** was defined as binding at the end of 1999, thus guaranteeing the interaction of all PROFIBUS-based devices in a plant.
This profile defines the functionality of the analyzers in a block model: e.g. the **physical block** describes the measuring procedure, analyzer and vendor names, serial number and operating state (operation, maintenance). Various **functional blocks** contain the execution of specific functions such as the processing of measured values or alarms. The **transducer blocks** describe the functionality of the actual measuring procedure and its control, e.g. preprocessing of a measured value, correction of cross-interferences, characteristics, measuring ranges as well as switching and control procedures. Protocols define the data transmission between the stations on the bus. A differentiation is made between **cyclic and acyclic services**. Cyclic services are used to transmit time-critical data such as measured values and statuses. The acyclic services permit the scanning or modification of device parameters during operation.
All gas analyzers of Series 6, ULTRAMAT 6, ULTRAMAT/OXYMAT 6, OXYMAT 6, OXYMAT 61 and CALOMAT 6, as well as the ULTRAMAT 23 are suitable for PROFIBUS when fitted with the optional plug-in card (retrofitting also possible, see Ordering information).

Example interfering gas correction

Specification for interface cable

Characteristic impedance	100 to 300 Ω, with a measuring frequency of > 100 kHz
Cable capacity	typ. < 60 pF/m
Wire section	> 0.22 mm^2, corresp. AWG 23
Cable type	twisted pairs, 1 x 2 wire of cable section
Signal attenuation	max. 9 dB over the whole length
Screening	copper braid shield or braid shield and foil screen
Connection	pin 3 and pin 8

Bus terminating resistors

The pin 3-7 and 8-9 of the first and last connector of a bus cable have to be bridged (see figure below).

Note

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

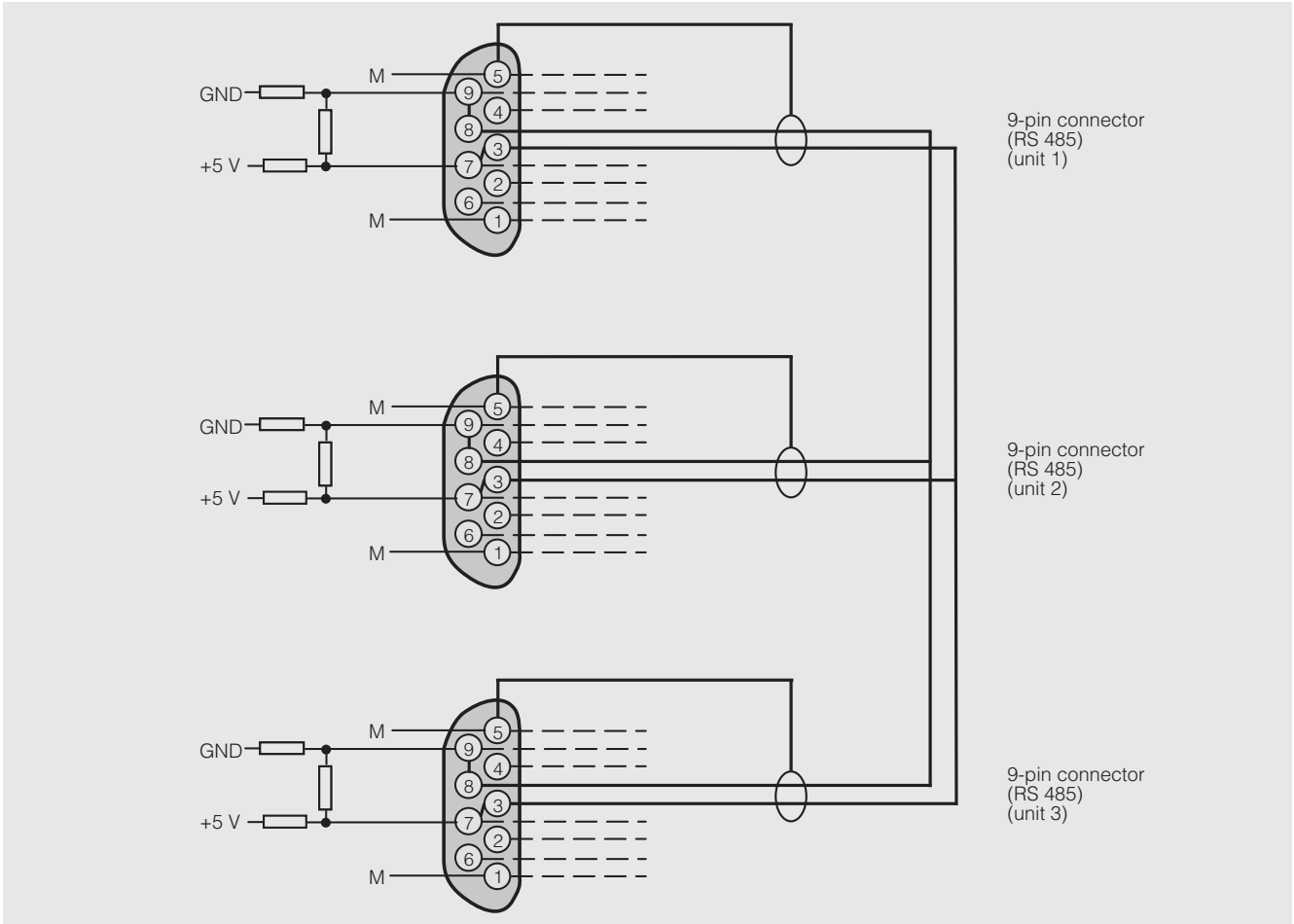


Fig. 5 Bus cable with connector assignments

Gas and electrical connections

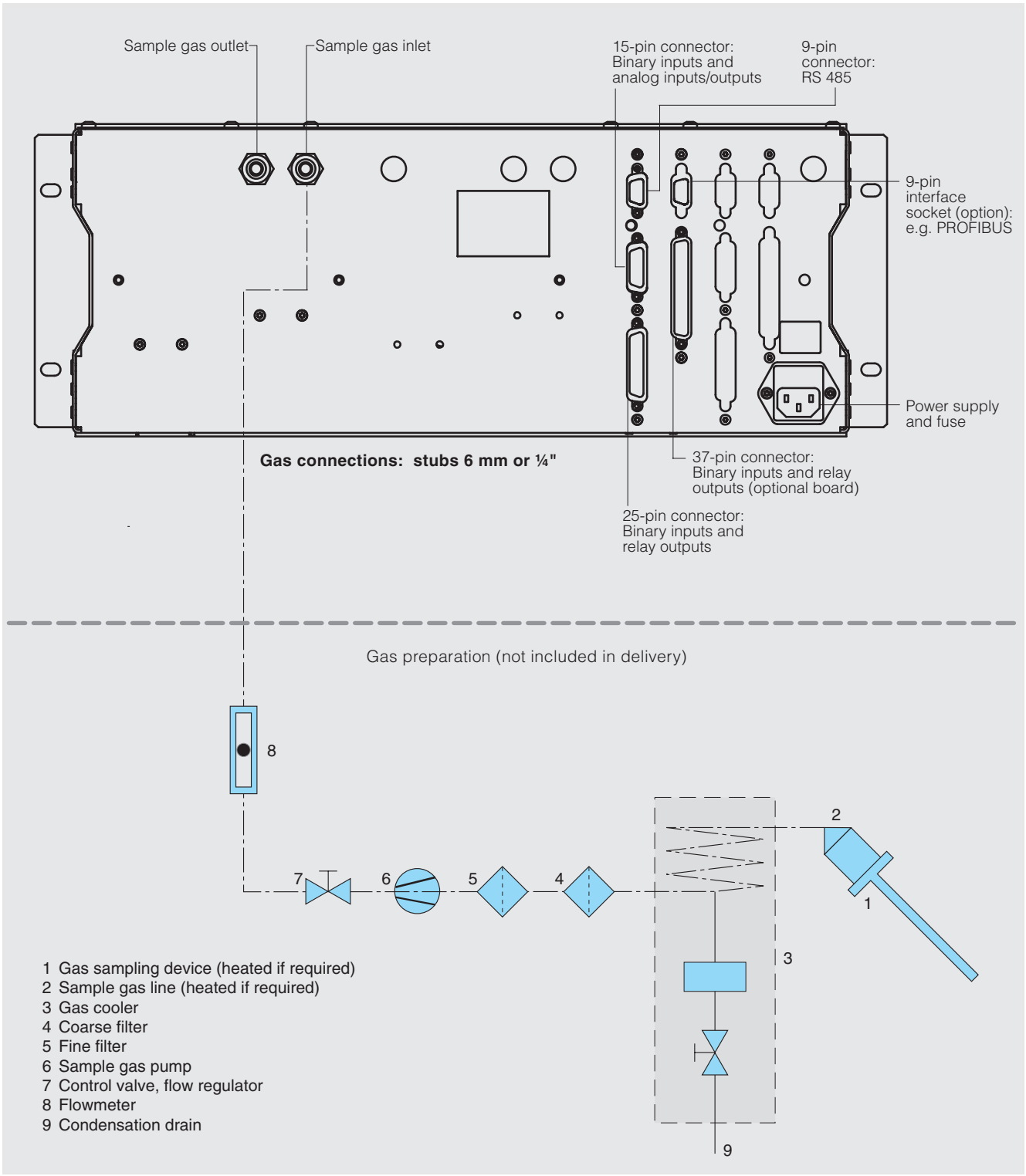


Fig. 6 CALOMAT 6, 19" unit, gas and electrical connections shown at top, gas preparation shown at bottom

Pin assignment

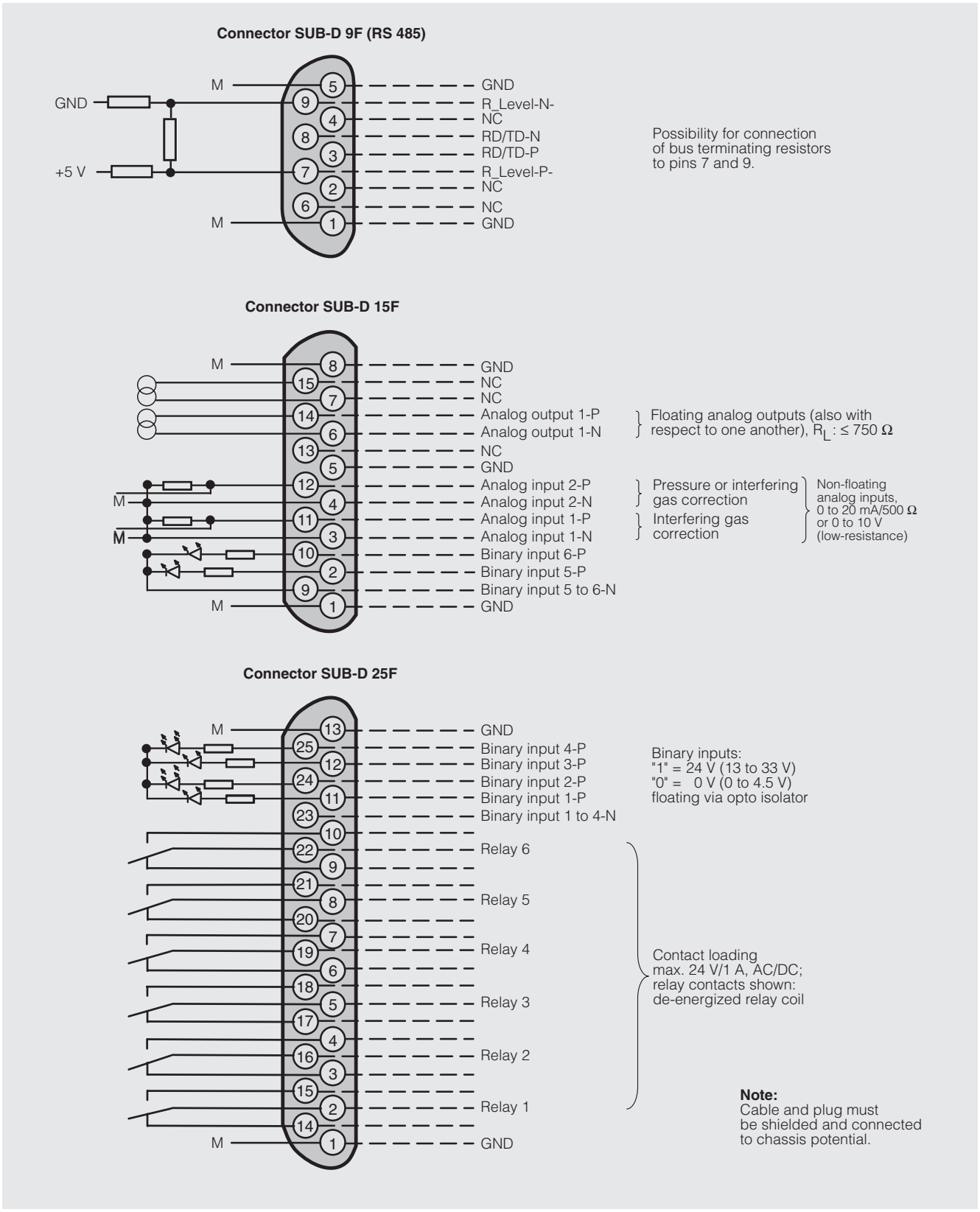


Fig. 7 CALOMAT 6, 19“ unit, pin assignment

Electrical connection

Pin assignment (continued)

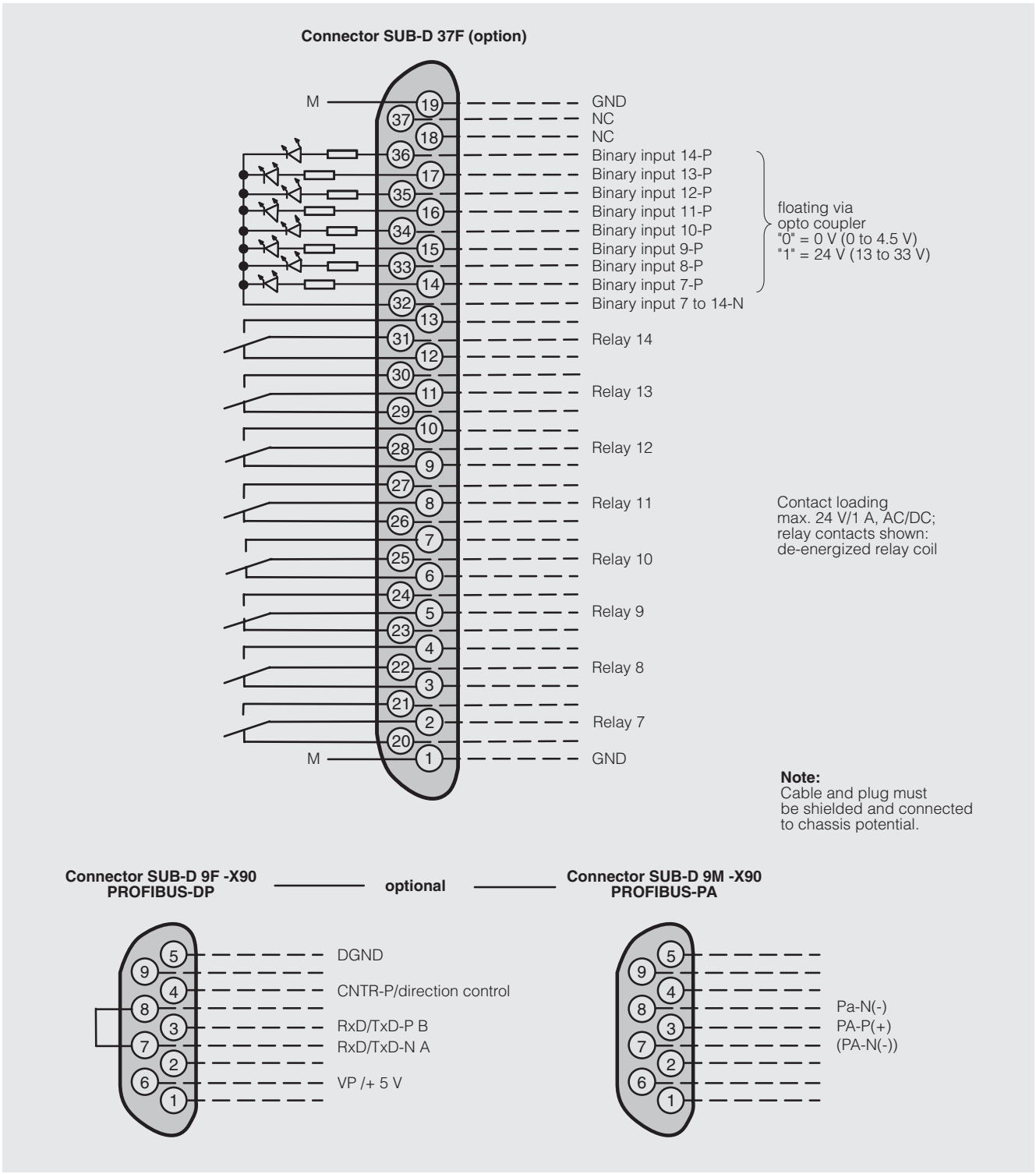


Fig. 8 CALOMAT 6, 19“ unit, pin assignment of Autocal board and PROFIBUS connectors

Technical data [1])

General	
Measuring ranges	4, switchable internally and externally; autoranging is also possible
Largest possible measuring span	100 % H_2 (smallest possible measuring span see page 4)
Measuring ranges with suppressed zero	Any zero point within 0 to 100 % can be achieved; smallest possible measuring span 5 % H_2
Position of use	Front panel vertical
Conformity	CE identification EN 61326/A1, EN 61010/1
Design, enclosure	
Degree of protection	IP 20 according to EN 60529
Dimensions	see Fig. 9
Weight	Approx. 10 kg
Electrical characteristics	
EMC interference immunity [2]) (**E**lectro**M**agnetic **C**ompatibility)	According to standard requirements of NAMUR NE21 (08/98)
Electrical safety	According to EN 61010-1, overvoltage category II
Power supply (see rating plate)	AC 100 -10 % to 120 V +10 %, 47 to 63 Hz or AC 200 -10 % to 240 V +10 %, 47 to 63 Hz
Fuses	100...120 V: 1.0T/250 200...240 V: 0.63T/250
Power consumption	Approx. 20 VA
Gas inlet conditions	
Sample gas pressure	800...1100 hPa (absolute)
Sample gas flow	30...90 l/h (0.5...1.5 l/min)
Sample gas temperature	0 to 50 °C
Sample cell temperature	Approx. 60 °C
Sample gas humidity	< 90 % RH [3])
Time response	
Warm-up period	< 30 min [4])
Response time (T_{90})	< 5 s
Damping (electric time constant)	0 to 100 s, programmable
Dead time (purging time of gas path in analyzer at 1 l/min)	Approx. 0.5 s

Measuring response [5])	
Output signal fluctuation	< ± 0.75 % of smallest possible measuring range specified on rating plate with an electronic time constant of 1 s (σ = 0,25 %)
Zero drift	< 1 %/week of smallest possible measuring span specified on rating plate
Repeatability	< 1 % of respective measuring span
Linearity error	< ± 1 % of respective measuring span
Influencing variables [5])	
Ambient temperature	< 1 %/10 K referred to the smallest possible measuring span according to rating plate
Residual gases	Deviation in zero point (cross interference see Table page 4)
Sample gas flow	< 0.1 % of smallest possible measuring span according to rating plate with a change in flow of 10 l/h within the permissible flow range
Sample gas pressure	< 1 % for a pressure variation of 100 hPa
Power supply	< 0.1 % of output signal span with rated voltage ± 10 %
Electric inputs and outputs	
Analog output	0/2/4 to 20 mA, floating; max. load 750 Ω
Relay outputs	6, with changeover contacts, freely selectable, e.g. for range identification; loading capacity: 24 V AC/DC/ 1 A, floating
Analog inputs	2, designed for 0/2/4 to 20 mA, for external pressure sensor and correction of influence of residual gas
Binary inputs	6, designed for 24 V, floating, freely selectable, e.g. for range switching
Serial interface	RS 485
Options	Autocal function with 8 binary inputs and 8 relay outputs; also with PROFIBUS-PA or PROFIBUS-DP
Ambient conditions	
Perm. ambient temperature	-30 to +70 °C during storage and transport, +5 to +45 °C during operation
Permissible humidity [6])	< 90 % RH [3]) as annual average, during storage and transport

[1]) Following DIN EN 61207 / IEC 1207.
All data referred to binary gas mixture H_2 in N_2.
[2]) All signal wires must be shielded.
[3]) RH: relative humidity.
[4]) Maximum accuracy achieved after 2 hours.
[5]) Referred to 1000 hPa absolute sample gas pressure, 0.5 l/min sample gas flow and 25 °C ambient temperature.
[6]) Dew point must not be fallen below.

Dimensions

Dimensions

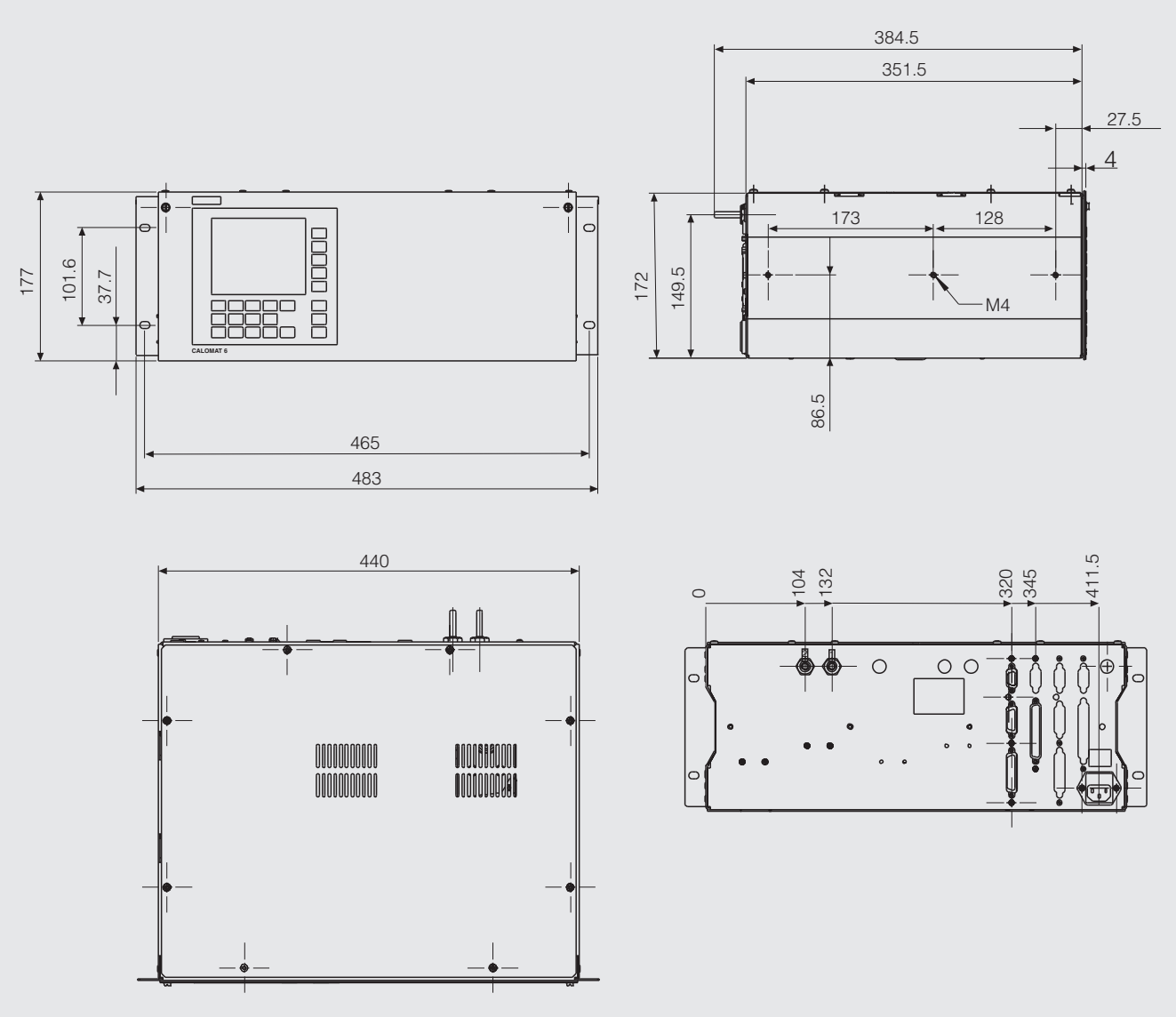


Fig. 9 CALOMAT 6, 19“ unit, dimensions in mm

Ordering data

Order No.

CALOMAT 6 gas analyzer
19“ unit for installation in cabinets

7MB2521- - ■ ■ ■ **0** ■ - ■ **A A** ■

		Order No.
Gas connections for sample gas		
Piping with outer diameter 6 mm		**0**
Piping with outer diameter ¼"		**1**
Measured component	**Smallest meas. range**	
H_2 in N_2	0 - 1 / 100 %	**A A**
H_2 in N_2 (blast furnace gas meas.) [1]	0 - 1 / 100 %	**A W**
H_2 in N_2 (converter gas meas.) [1]	0 - 1 / 100 %	**A X**
H_2 in N_2 (wood gasification) [1]	0 - 1 / 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**
Supplementary electronics		
Without		**0**
Autocal function		
• With additional 8 binary inputs/outputs		**1**
• With additional 8 binary inputs/outputs and PROFIBUS-PA interface		**6**
• With additional 8 binary inputs/outputs and PROFIBUS-DP interface		**7**
Power supply		
100 V to 120 V AC, 47 to 63 Hz		**0**
200 V to 240 V AC, 47 to 63 Hz		**1**
Language		
German		**0**
English		**1**
French		**2**
Spanish		**3**
Italian		**4**

[1]) Prepared for supplying external correction of cross interferences.

Ordering data
CALOMAT 6

Ordering data (continued)

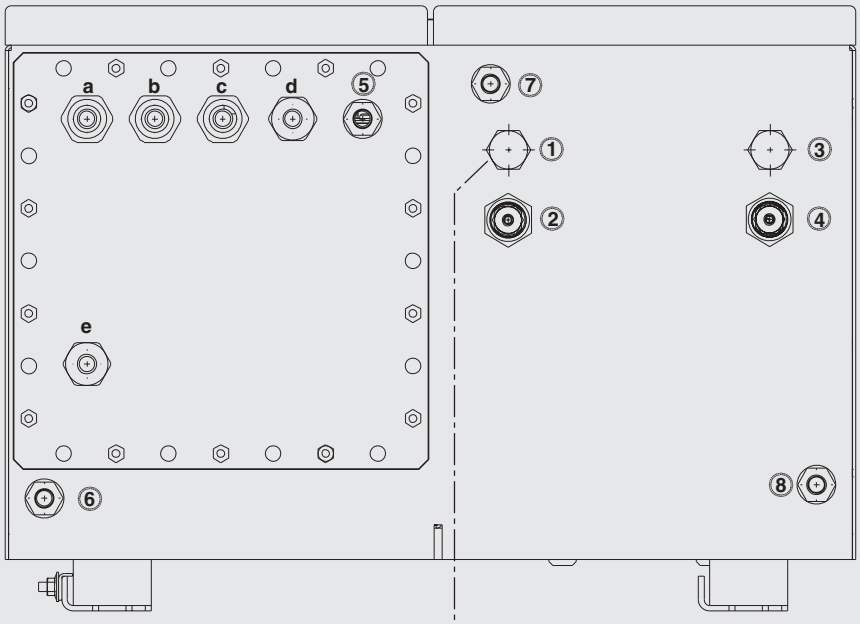
Further versions Please add „-**Z**“ to Order No. and specify Order code	Order code
RS 485/RS 232 converter	**A11**
Slide rails (2 rails)	**A31**
Set of Torx tools, socket spanner	**A32**
TAG labels (customer-defined inscriptions)	**B03**
Customer acceptance (in factory before delivery) [1]	**Y01**
Drift recording [2]	**Y03**
Measuring range in plain text if different from standard setting [3]	**Y11**
Retrofitting sets	Order No.
RS 485/Ethernet converter	**C79451-A3364-D61**
RS 485/RS 232 converter	**C79451-Z1589-U1**
Autocal function with 8 binary inputs/outputs	**C79451-A3480-D511**
Autocal function with 8 binary inputs/outputs and PROFIBUS-PA	**A5E00057307**
Autocal function with 8 binary inputs/outputs and PROFIBUS-DP	**A5E00057312**

[1]) Customer acceptance: ½ day at factory in presence of customer.
The following work is carried out: comparison of analyzer with ordering data;
linearization check (zero, mid-point value and full-scale value);
reproducibility check with calibration gas (recording in each case on XT recorder, logging of results).

[2]) Drift recording: an XT recording is supplied when the analyzer is delivered:
zero drift with 16 hours continuous operation and sensitivity drift (largest measuring range)
with 6 hours continuous operation.

[3]) Standard setting: Measuring range 1: 0 to smallest measuring range
Measuring range 2: 0 to 10 % (25 %)
Measuring range 3: 0 to 25 % (50 %)
Measuring range 4: 0 to largest measuring range.

Gas and electrical connections (unit underside)



Gas connections

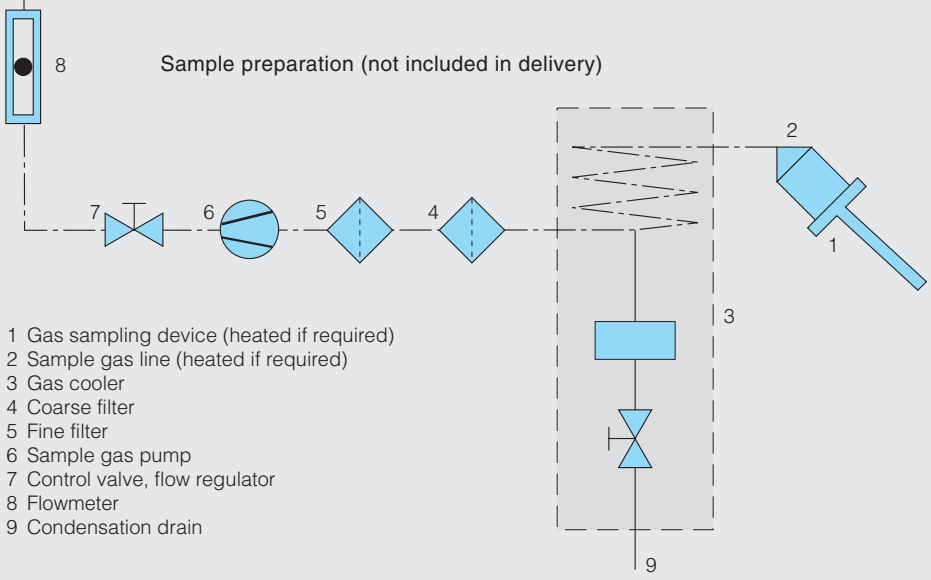
①	not used
②	Sample gas inlet
③	not used
④	Sample gas outlet
⑤-⑧	Purging gas inlet/outlet

Clamping ring connection for pipe Ø 6 mm or ¼"

Stub Ø 10 mm or 3/8 "

Electrical connections

a - c	Signal line (analog + digital): Pg 16
d	Interface connection: Pg 13.5
e	Supply connection: Pg 13.5



1 Gas sampling device (heated if required)
2 Sample gas line (heated if required)
3 Gas cooler
4 Coarse filter
5 Fine filter
6 Sample gas pump
7 Control valve, flow regulator
8 Flowmeter
9 Condensation drain

Fig. 10 ULTRAMAT 6, field unit, gas and electrical connections shown at top, installation preparation with external gas preparation (example) shown at bottom

Electrical connection

Pin assignment

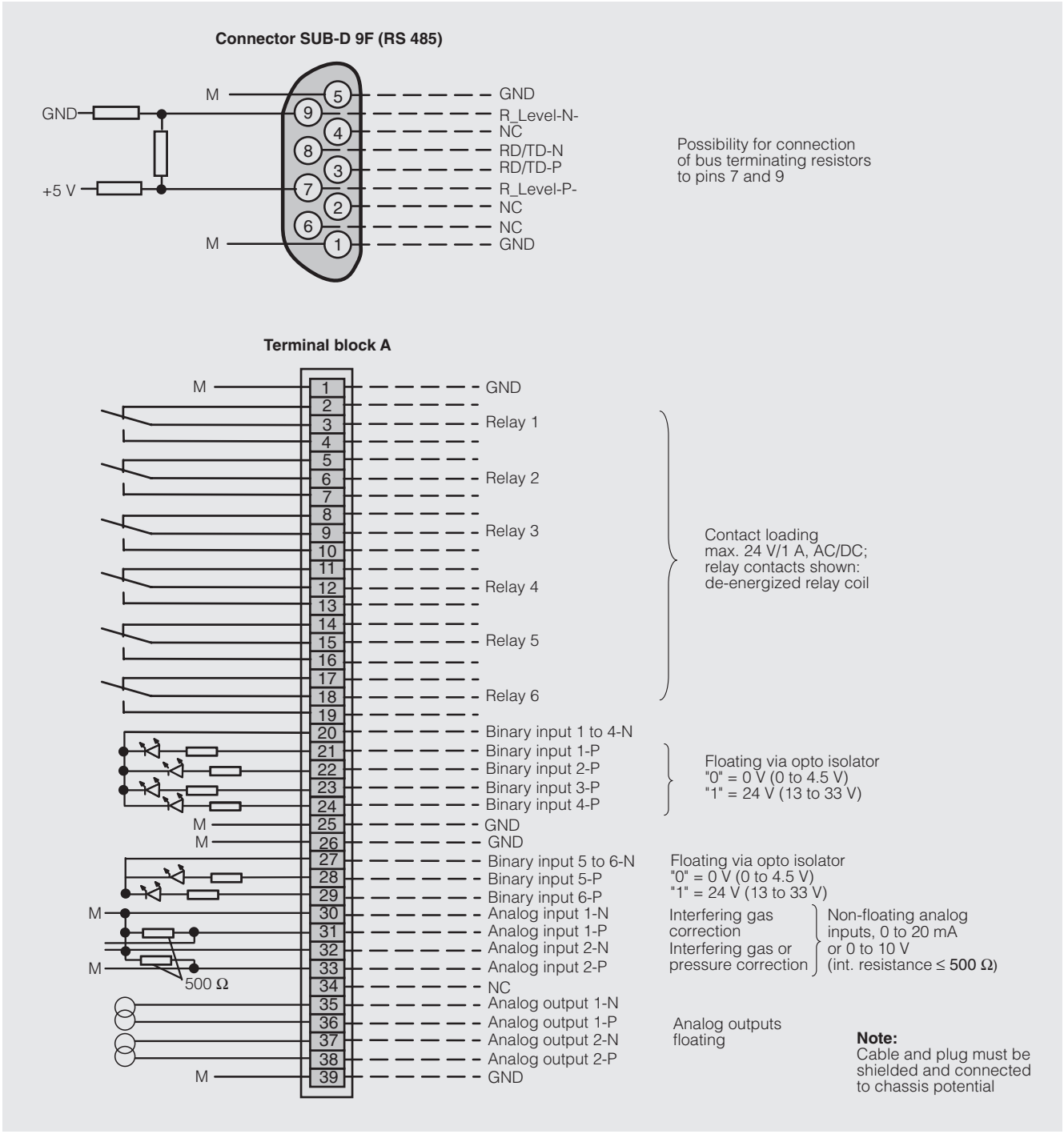


Fig. 11 CALOMAT 6, field unit, connector and terminal assignment

Pin assignment (continued)

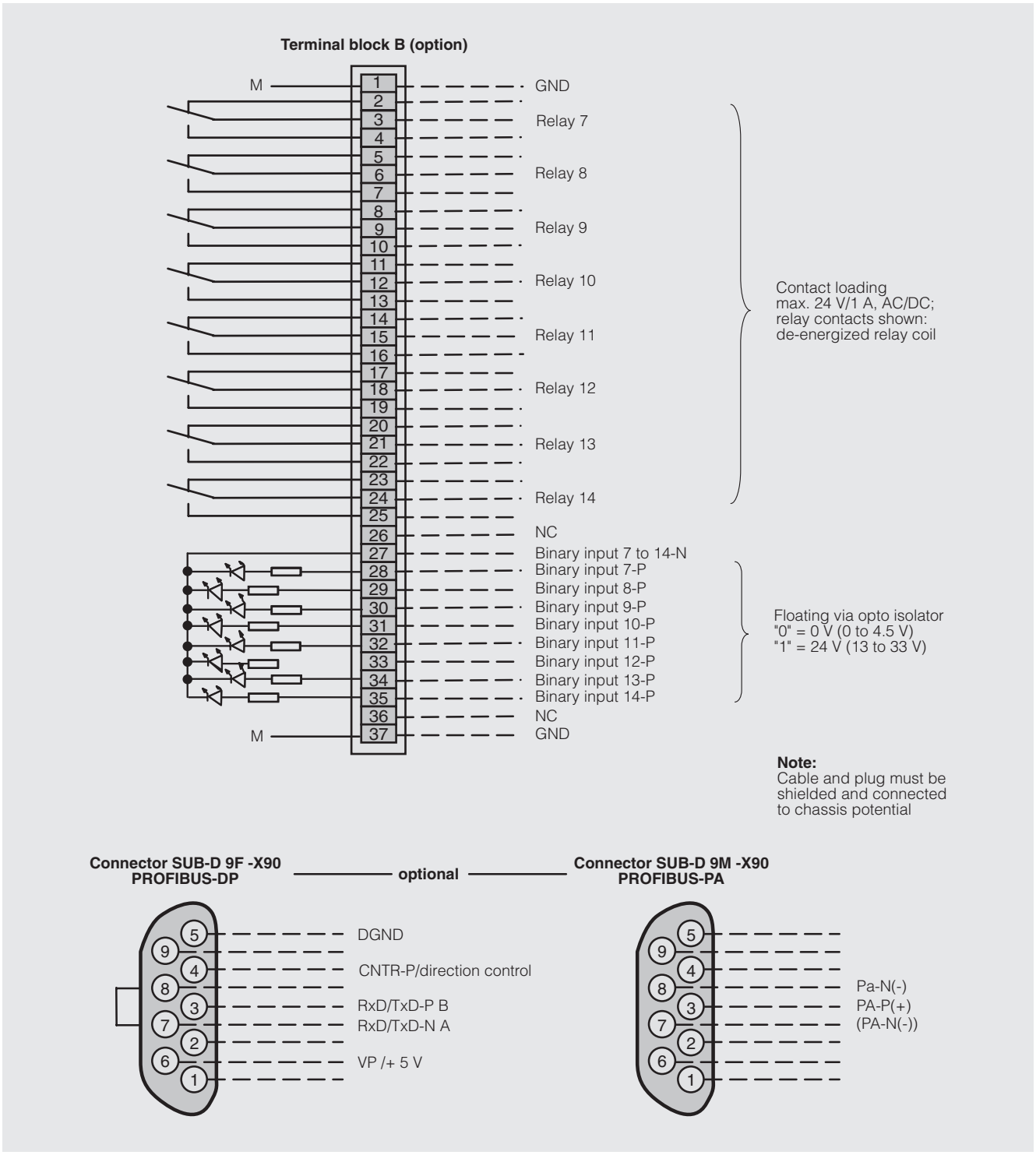


Fig. 12 CALOMAT 6, field unit, connector and terminal assignment of the Autocal board and PROFIBUS connectors

Technical data

Technical data [1]

General	
Measuring ranges	4, switchable internally and externally; autoranging is also possible
Largest possible measuring span	100 % H_2 (smallest possible measuring span see page 4)
Measuring ranges with suppressed zero	Any zero point within 0 to 100 % can be achieved; smallest possible measuring span 5 % H_2
Position of use	Front panel vertical
Conformity	CE identification to EN 61326/A1, EN 61010/1
Design, enclosure	
Degree of protection	IP 65 according to EN 60529
Dimensions	see Fig. 13
Weight	Approx. 25 kg
Electrical characteristics	
EMC interference immunity [2] (**E**lectro**M**agnetic **C**ompatibility)	According to standard requirements of NAMUR NE21 (08/98)
Electrical safety	According to EN 61010-1, overvoltage category II
Power supply (see rating plate)	AC 100 -10 % to 120 V +10 %, 47 to 63 Hz or AC 200 -10 % to 240 V +10 %, 47 to 63 Hz
Power consumption	Approx. 20 VA
Fuses	100...120 V: 1.0T/250 200...240 V: 0.63T/250
Gas inlet conditions	
Sample gas pressure	800...1100 hPa (absolute)
Sample gas flow	30...90 l/h (0.5...1.5 l/min)
Sample gas temperature	0 to 50 °C
Sample cell temperature	Approx. 60 °C
Sample gas humidity	< 90 % RH [3]
Purging gas pressure • permanent • for short periods	 165 hPa above environment max. 250 hPa above environment
Time response [4]	
Warm-up period	< 30 min [5]
Response time (T_{90})	< 5 s
Damping (electric time constant)	0 to 100 s, programmable
Dead time (at 1 l/min)	Approx. 0.5 s

Measuring response [4]	
Output signal fluctuation [5]	< ± 0.75 % of smallest possible measuring range specified on rating plate with an electronic time constant of 1 s (σ = 0,25 %)
Zero drift	< 1 %/week of smallest possible measuring span specified on rating plate
Repeatability	< 1 % of respective measuring span
Linearity error	< ± 1 % of respective measuring span
Influencing variables [4]	
Ambient temperature	< 1 %/10 K referred to the smallest possible measuring span according to rating plate
Residual gases	Deviation in zero point (cross interference see Table page 4)
Sample gas flow	< 0.2 % of smallest possible measuring span according to rating plate with a change in flow of 0.1 l/h within the permissible flow range
Sample gas pressure	< 1 % for a pressure variation of 100 hPa
Power supply	< 0.1 % of output signal span with rated voltage ± 10 %
Electric inputs and outputs	
Analog output	0/2/4 to 20 mA, floating; max. load 750 Ω
Relay outputs	6, with changeover contacts, freely selectable, e.g. for range identification; loading capacity: 24 V AC/DC/ 1 A, floating
Analog inputs	2, designed for 0/2/4 to 20 mA, for external pressure sensor and correction of influence of residual gas (correction of cross interference)
Binary inputs	6, designed for 24 V, floating, freely selectable, e.g. for range switching
Serial interface	RS 485
Options	Autocal function with 8 binary inputs and 8 relay outputs; also with PROFIBUS-PA or PROFIBUS-DP
Ambient conditions	
Perm. ambient temperature	-30 to +70 °C during storage and transport, +5 to +45 °C during operation
Permissible humidity [6]	< 90 % RH [3] as annual average, during storage and transport

[1] Following DIN EN 61207 / IEC 1207.
All data referred to binary gas mixture H_2 in N_2.

[2] All signal wires must be shielded.
Errors of up to 4 % of the smallest measuring range can occur in zones with strong electromagnetic interferences.

[3] RH: relative humidity.

[4] Referred to 1000 hPa absolute sample gas pressure, 0.5 l/min sample gas flow and 25 °C ambient temperature.

[5] Maximum accuracy achieved after 2 hours.

[6] Dew point must not be fallen below.

Dimensions

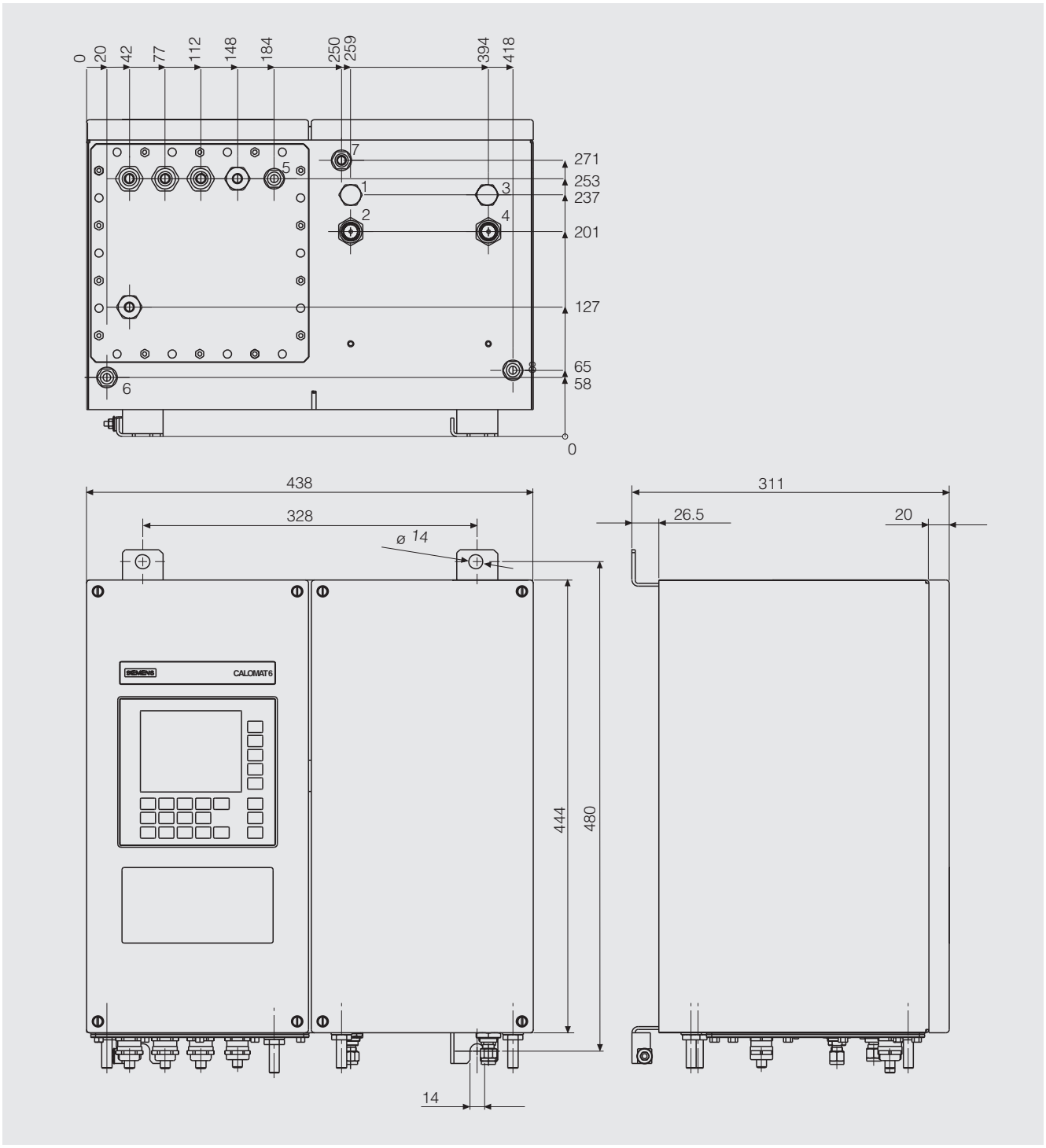


Fig. 13 CALOMAT 6, field unit, dimensions in mm

Ordering data
CALOMAT 6F

Ordering data

		Order No.	
CALOMAT 6F gas analyzer for field mounting		**7MB2511-** **- ■ ■ ■ 0 ■ - ■ A ■ ■**	**cannot be combined**
Gas connections for sample gas			
Clamping ring connection with pipe outer diameter 6 mm		0	
Clamping ring connection with pipe outer diameter ¼"		1	
Measured component	**Smallest range**		
H_2 in N_2	0 - 1 / 100 %	A A	
H_2 in N_2 (blast furnace gas meas.) [1])	0 - 1 / 100 %	A W	
H_2 in N_2 (converter gas meas.) [1])	0 - 1 / 100 %	A X	
H_2 in N_2 (wood gasification) [1])	0 - 1 / 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	
Supplementary electronics			
Without		0	
Autocal function			
• With additional 8 binary inputs/outputs		1	
• With additional 8 binary inputs/outputs and PROFIBUS-PA interface		6	6
• With additional 8 binary inputs/outputs and PROFIBUS-DP interface		7	7
• With additional 8 binary inputs/outputs and PROFIBUS-PA Ex i interface		8	
Power supply			
100 V to 120 V AC, 47 to 63 Hz		0	
200 V to 240 V AC, 47 to 63 Hz		1	
Explosion protection			
Without		A	
Certificate: ATEX 100; II 3G EEx nR; restricted breathing enclosure (Ex zone 2) (only for gas mixtures < LEL)		B	
Certificate: ATEX 100; II 2/3G EEx nRP (Ex zone 2) [2])		C	
FM, Class 1, Div. 2 [2])		D	
ATEX 100, Ex-Zone 1 (mode: leakage compensation) [2])		E	E
ATEX 100, Ex-Zone 1 (mode: continuous purging) [2])		F	F
Language			
German		0	
English		1	
French		2	
Spanish		3	
Italian		4	

[1]) Prepared for supplying external correction of cross interferences.
[2]) Only in conjunction with an approved purging unit.

Ordering data (continued)

Further versions Please add „-**Z**“ to Order No. and specify Order code	Order code
RS 485/RS 232 converter	**A11**
Set of Torx tools, socket spanner	**A32**
TAG labels (customer-defined inscriptions)	**B03**
Customer acceptance (in factory before delivery) [1])	**Y01**
Drift recording [2])	**Y03**
Extended customer acceptance of analyser + function demonstration of the BARTEC Ex purging enclosure	**Y04**
Measuring range in plain text if different from standard setting [3])	**Y11**
Additional units for explosion-proof versions, ATEX categorie 2G (zone 1)	Order No.
Bartec EEX P control unit, 230 V, „leakage compensation“	**7MB8000-2BA**
Bartec EEX P control unit, 115 V, „leakage compensation“	**7MB8000-2BB**
Bartec EEX P control unit, 230 V, „continuous purging“	**7MB8000-2CA**
Bartec EEX P control unit, 115 V, „continuous purging“	**7MB8000-2CB**
Explosion-protected isolation amplifier	**7MB8000-3AA**
Explosion-protected isolating relays	**7MB8000-4AA**
Differential pressure switch for corrosive gases	**7MB8000-5AA**
Differential pressure switch for non-corrosive gases	**7MB8000-5AB**
Flame inhibitor made of stainless steel	**7MB8000-6AA**
Flame inhibitor made of Hastelloy	**7MB8000-6AB**
Additional units for explosion-proof designs, ATEX category 3G (zone 2)	Order No.
Ex purging unit Minipurge FM	**7MB8000-1AA**
Bartec EEx p control unit (for units with order code E12)	**7MB8000-1BA**
Retrofitting sets	Order No.
RS 485/Ethernet converter	**C79451-A3364-D61**
RS 485/RS 232 converter	**C79451-Z1589-U1**
Autocal function with 8 binary inputs/outputs	**A5E00064223**
Autocal function with 8 binary inputs/outputs and PROFIBUS-PA	**A5E00057315**
Autocal function with 8 binary inputs/outputs and PROFIBUS-DP	**A5E00057318**
Autocal function with 8 binary inputs/outputs and PROFIBUS-PA Ex i (requires Firmware 4.110)	**A5E00057317**

[1]) Customer acceptance: ½ day at factory in presence of customer.
The following work is carried out: comparison of analyzer with ordering data;
linearization check (zero, mid-point value and full-scale value);
reproducibility check with calibration gas (recording in each case on XT recorder, logging of results).

[2]) Drift recording: an XT recording is supplied when the analyzer is delivered:
zero drift with 16 hours continuous operation and sensitivity drift (largest measuring range)
with 6 hours continuous operation.

[3]) Standard setting: Measuring range 1: 0 to smallest measuring range
Measuring range 2: 0 to 10 %
Measuring range 3: 0 to 25 %
Measuring range 4: 0 to 100 %

Explosion-proof design

Use of the CALOMAT 6 in hazardous areas

Suitability-tested field analyzers of series 6 must be used to measure gases in hazardous areas. The preferred explosion protection for these analyzers is the pressurized enclosure EEx p for zone 1 or the simplified pressurized enclosure EEx n P for zone 2. In addition, these analyzers must be connected to monitoring equipment which must also be suitability-tested for zone 1.

Exception: a pressurized enclosure is not required in zone 2 for the measurement of gases whose composition always remains below the lower explosion limit (LEL); in this case it is sufficient for the field housing to be gas damp-proof (type of protection EEx n R).

Following pre-purging of 5 minutes, the monitoring equipment ensures that no gas damp can enter the housing, and accumulation of the sample gas in the housing is prevented. The volume flow during the pre-purging phase is > 50 l/min. The protective gas is usually fed into the analyzer housing from a supply network via the monitoring equipment.

Ex zone 1

Two versions of pressurized enclosure EEx p complying with directive 94/9/EC are available for use in zone 1:

- *Pressurized enclosure with compensation of losses resulting from leaks*
  Only that volume of protective gas required to hold an overpressure of at least 50 Pa compared to the sample gas pressure *and* atmospheric pressure is fed into the housing.
  The maximum purging gas pressure is 165 hPa; this causes a max. permissible sample gas pressure of 160 hPa.
  Test certificate: PTB 00 ATEX 2022 X
  Analyzer identification: II 2 G EEx p [ia] ia IIC T4
- *Pressurized enclosure with continuous purging*
  Protective gas continuously flows through the housing with a volume flow of at least 1 l/min; furthermore, the flow results in an overpressure in the housing of at least 50 Pa compared to atmospheric pressure.
  The max. permissible purging gas pressure is 25 hPa. The max. permissible sample gas pressure is equivalent to the analyzer sample gas pressure.
  Test certificate: TÜV 01 ATEX 1708 X
  Analyzer identification: II 2 G EEx p [ia] ia IIC T4

The fundamental safety requirements are satisfied by compliance with the European standards
EN 50014:1997, EN 50016:1995, EN 50020:1994 and
EN 954:1996.

The EExp monitoring equipment is a stand-alone unit which is connected electrically and pneumatically to the analyzer. Ex protection is only provided when these two units are connected together.

Ex zone 2

Two versions complying with directive 94/9/EC are available for use in zone 2:

- *Ex protection resulting from gas damp-proof housing*
  The housing is sealed sufficiently such that gas damp cannot penetrate. With this type of protection, only sample gases may be connected which are below the LEL.
  Test certificate: TÜV 01 ATEX 1686 X
  Analyzer identification: II 3 G EEx n R II T6
- *Simplified pressurized enclosure with continuous purging*
  This type of protection must always be selected if flammable gases or gas mixtures are to be connected.
  Protective gas continuously flows through the housing with a volume flow of at least 1 l/min; furthermore, the flow results in an overpressure in the housing of at least 50 Pa compared to atmospheric pressure. Manually controlled pre-purging with the analyzer power supply switched off is sufficient for the simplified pressurized enclosure. It is not necessary for the analyzer to be switched off automatically should the protective gas fail.
  Test certificate: TÜV 01 ATEX 1697 X
  Analyzer identification: II 2/3 G EEx n P II T4

The fundamental safety requirements are satisfied by compliance with the European standards
EN 50021:1999, EN 60079:1997, Sec. 13 and ZH 1/10, Sec. 1.

The EEx nP monitoring equipment is a stand-alone unit which is connected electrically and pneumatically to the analyzer. Ex protection is only provided when these two units are connected together.

FM Class 1 Div 2

The same applies here as to the simplified pressurized enclosure with continuous purging; the required Ex protection is only provided when appropriate equipment is connected.

Type of protection and flame inhibitor

It generally applies that selection of the protective gas and use of flame inhibitors depend on the type of sample gas:

- Connection of combustible gases above the LEL always require an inert gas (e.g. N_2) as the protective gas. Furthermore, the process must be protected by flame inhibitors if it cannot be excluded that explosive gas mixtures could occasionally be present in the sample gas path.
- Gas mixtures which could be frequently or permanently explosive must not be connected!
- With gases below the LEL, air can also be used as the protective gas, and flame inhibitors can be omitted.

Type of gas / Zone	Sample gas non-flammable, or permanently below the lower explosive limit (LEL)	Sample gas seldom above LEL, and only briefly in such cases	Sample gas occasionally above LEL
0	**Not possible**	**Not possible**	**Not possible**
1	•Analyzer in ATEX 100a - EEx p version •Tube for gas path •EEx p control unit in mode "Leakage compensation"	•Analyzer in ATEX 100a - EEx p version •Tube for gas path Sample gas pressure < 165 hPa, fail-safe: •EEx p control unit in mode "Leakage compensation" •Differential pressure switch (if the sample gas pressure is not controlled fail-safe) Sample gas pressure occasionally > 165 hPa: •EEx p control unit in mode "Continuous purging"	•Analyzer in ATEX 100a - EEx p version •Tube for gas path •Flame inhibitors in sample gas inlet/outlet [1]) Sample gas pressure < 165 hPa, fail-safe: •EEx p control unit in mode "Leakage compensation" •Differential pressure switch (if the sample gas pressure is not controlled fail-safe) Sample gas pressure occasionally > 165 hPa: •EEx p control unit in mode "Continuous purging"
2	•Analyzer in field housing with degree of protection EEx nR (restricted breathing enclosure) •Tube for gas path	•Analyzer in field housing with degree of protection EEx nP •Tube for gas path •Simplified pressurized enclosure with continuous purging with inert gas or EEx nRP (restricted breathing enclosure for electronics unit, and simplified pressurized enclosure for physical unit with continuous purging with inert gas)	•Analyzer in field housing with degree of protection EEx nP •Tube for gas path •Flame inhibitors in sample gas inlet/outlet [1]) •Simplified pressurized enclosure with continuous purging with inert gas

Table 1 Explosion-proof configuration – Selection criteria in principle

Additional units (Ex zone 1)

	Signal wire guide		
	Ex 1 → Ex 1	**Ex 1 → Ex 2**	**Ex 1 → Ex free**
Ex-i isolation amplifier	required	conditional use (when energy recovery is not excluded)	conditional use (when energy recovery is not excluded)
Isolating relais	required	not required	not required
Pressure switches • **non-flammable gases** • **flammable gases**	 • not required • required (when the user pressure is not fail-safe)	 • not required • required (when the user pressure is not fail-safe)	 • not required • required (when the user pressure is not fail-safe)
Flame inhibitors	see above	see above	see above

Table 2 Additional units

[1]) The flame inhibitor in the sample gas outlet is not necessary when the sample gas is drawn in a non-explosive area.

BARTEC EEx p control unit

Description „Leakage compensation“

The APEX 2003.SI/A2 control unit controls and monitors the prepurging phase and the operating phase of gas analyzers with „Containment Systems“.
The control unit redundantly monitors the set overpressure of the purging gas. When the overpressure decreases, it is corrected to the adjustable setpoint (max. purging gas pressure 165 hPa).

4 programmable relay outputs and 8 relay contacts are available to interrupt the data lines.

Additional function

Due to the connection of additional pressure sensors, the internal pressure of the enclosure is maintained at a pressure higher than the sample gas with a proportional valve. During the prepurging phase the purging gas flow is max. 4100 Nl/h with an internal enclosure pressure of 50 hPa.

4 programmable relay inputs and 8 relay contacts are available to separate the data lines.

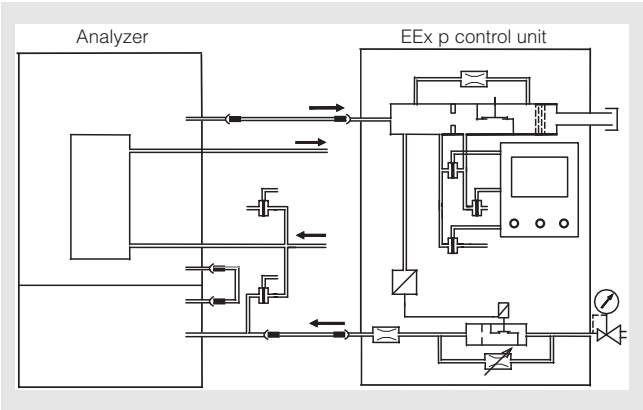


Fig. 14 BARTEC control unit, gas connection diagram

Technical data

Guidelines	EC EMC guideline 89/336/EEC EC low voltage RL 73/23/EWG Ex guideline 94/9EC
Design	Explosion-protected enclosure (EEx e) with viewing window in the cover
Enclosure material	glas-fiber reinforced polyester
Degree of protection	IP 65
Terminals	2.5 mm, stranded conductor
Pressure sensors	MIN A = 0 to 300 hPa MIN B = 0 to 300 hPa MAX = 0 to 300 hPa MAX 1 = 0 to 300 hPa DIFF A = 0 to 25 hPa DIFF B = 0 to 25 hPa
Prepurging time	0 to 99 min; 5 s delayed
Weight	11 kg
Electrical data	
Supply voltage	230 V AC (115 V AC)
Power consomption	21 W /230 V
NO contact	K2/3; max. 250 V, 5 A with cos φ = 1, K4/K5; supply voltage or floating, max. 250 V, 5 A with cos φ = 1
Communication	RS 485 interface
Temperature switching value (option)	0 to + 40 °C
Explosion-protected type	
Marking	EEx e d ib [ia p] IIC T4/T6
Certification	DMT 99 ATEX E 082
Ambient temperature	-20 to +40 °C

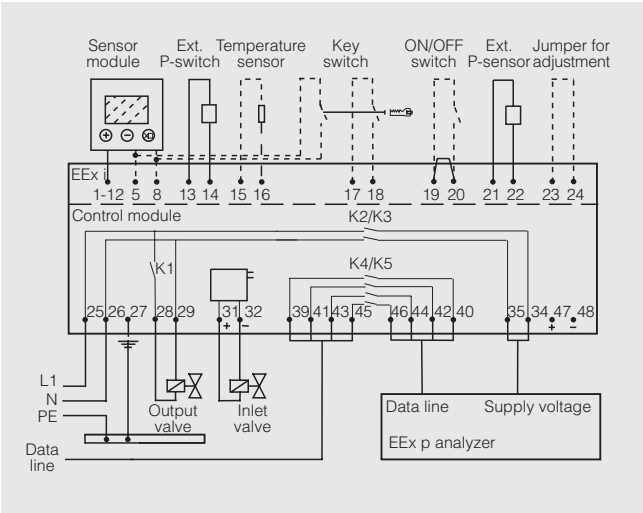


Fig. 15 BARTEC control unit, electric connection diagram

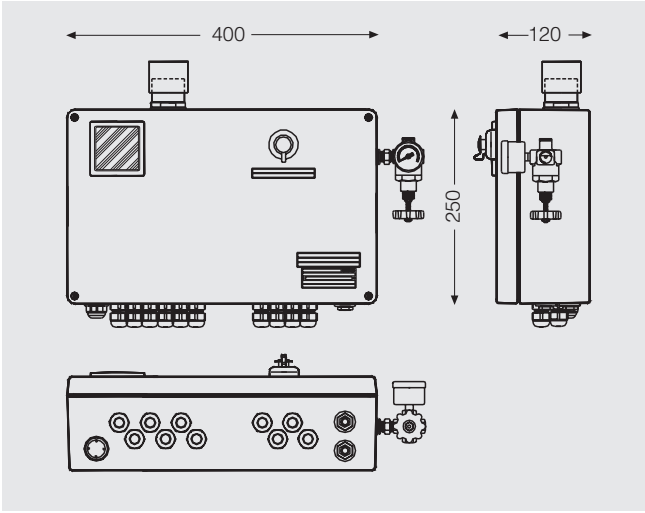


Fig. 16 BARTEC control unit, dimensions in mm

Description „Continuous purging“

The APEX 2003.SI/A4 control unit controls and monitors the prepurging phase and the operating phase of gas analyzers with „Containment Systems“.
The control unit redundantly monitors a continuous current of protection gas through the connected analyzer and thereby dilutes the eventually appearing sample gas below the lower explosive limit (max. purging gas pressure 25 hPa).

4 programmable relay outputs and 8 relay contacts are available to interrupt the data lines.

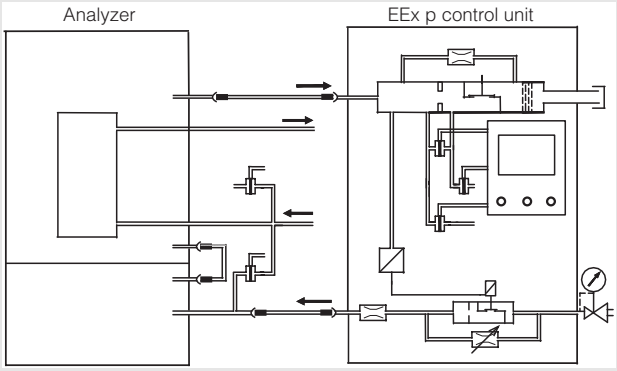


Fig. 17 BARTEC control unit, gas connection diagram

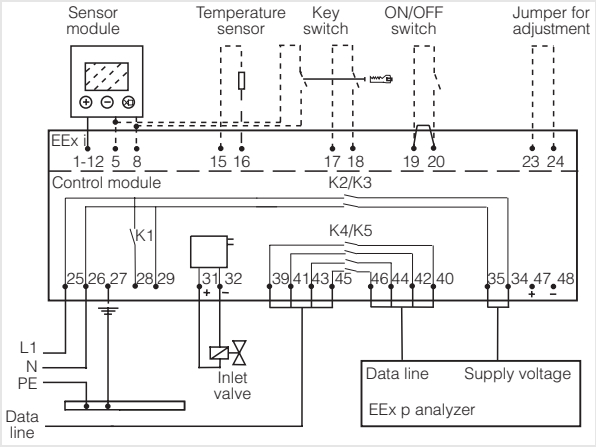


Fig. 18 BARTEC control unit, electric connection diagram

Technical data

Guidelines	EC EMC guideline 89/336/EEC EC low voltage RL 73/23/EWG Ex guideline 94/9EC
Design	Explosion-protected enclosure (EEx e) with viewing window in the cover
Enclosure material	glas-fiber reinforced polyester
Degree of protection	IP 65
Terminals	2.5 mm, stranded conductor
Pressure sensors	MIN A = 0 to 25 hPa MIN B = 0 to 25 hPa MAX = 0 to 25 hPa MAX 1 = 0 to 25 hPa DIFF A = 0 to 25 hPa DIFF B = 0 to 25 hPa
Prepurging time	0 to 99 min; 5 s delayed
Weight	10 kg
Electrical data	
Supply voltage	230 V AC (115 V AC)
Power consomption	14 W / 230 V
NO contact	K2/3; max. 250 V, 4 A with cos φ = 1, K4/K5; supply voltage or floating, max. 250 V, 5 A with cos φ = 1
Communication	RS 485 interface
Temperature switching value (option)	0 to + 40 °C
Explosion-protected type	
Marking	EEx e d ib [ia p] IIC T4/T6
Certification	DMT 99 ATEX E 082
Ambient temperature	-20 to +40 °C

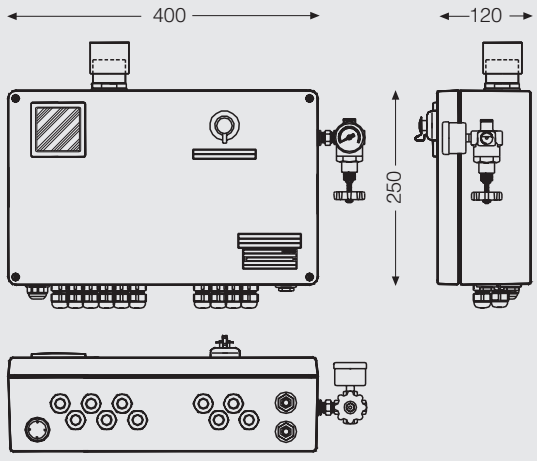


Fig. 19 BARTEC control unit, dimensions in mm

BARTEC EEx p control unit

Description, for flammable gases

Compact EEx p control unit for the explosion protection of pressurized analyzers in zone 2, inclusive redundant surveillance of the purging gas pressure and flow during purging and operating phase.

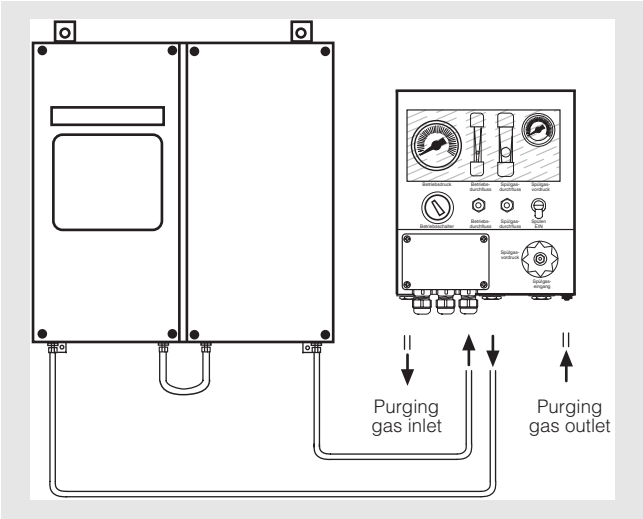


Fig. 20 BARTEC control unit, gas connection diagram

Technical data

Guidelines	EC EMC guideline 89/336/EEC RL 73/23/EWG Ex guideline 94/9EC
Design	Explosion-protected enclosure (EEx e) with viewing window in the cover
Enclosure material	stainless steel
Terminals	2.5 mm, stranded conductor
Pressures • Purging gas pressure • Purging gas flow • Operating pressure • Operating flow	 0.2 MPa to 1,0 MPa (0.2 MPa) 0 to 3.5 m^3/h (2,0 m^3/h) 0 to 60 hPa (8 hPa) 0 to 1.5 l/min (1 l/min)
Weight	4.3 kg
Electrical data	
Line voltage	0...230 V AC, 0...30 V DC
Switching capacity	max. 6 A with cos φ = 1 / max. AC 253 V max. 1.5 A with cos φ = 0,6 / max. AC 253 V max. 2 A with L/R ~ 0 ms / max. DC 30 V
Explosion-protected type	
Marking	EEx n A C R (P) II C T6
Certification	TÜV 01 ATEX 1748 X
Ambient temperature	-20 to +60 °C

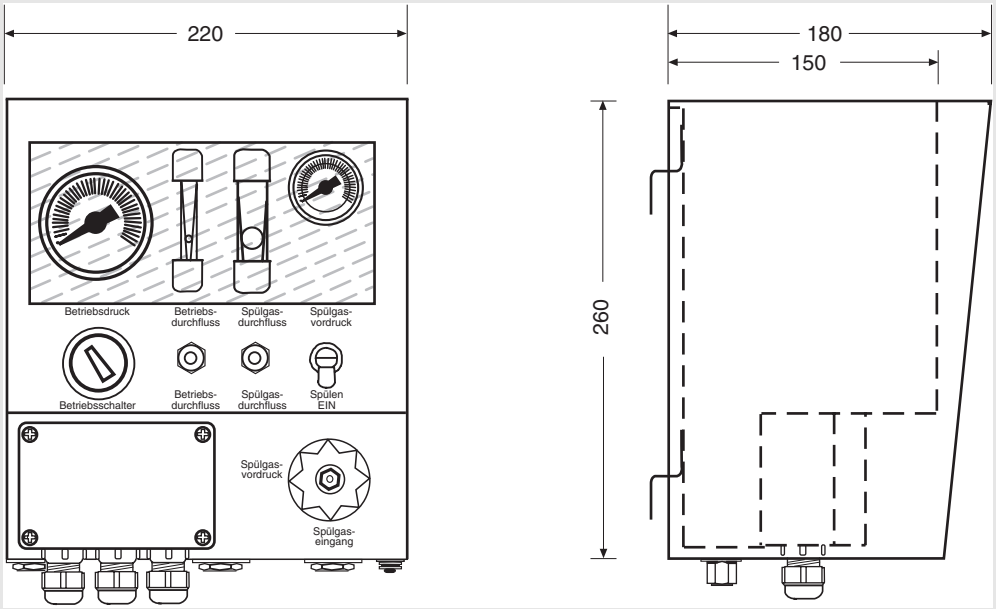


Fig. 21 BARTEC control unit, dimensions in mm

Description

The Ex purging unit MiniPurge FM is used to monitor the pressure during continuous purging of an analyzer with purging gas or inert gas. If the pressure falls below the set value, an optical display is triggered and the relay is activated. This monitoring unit is driven by the purging gas pressure and therefore does not require an additional power supply.

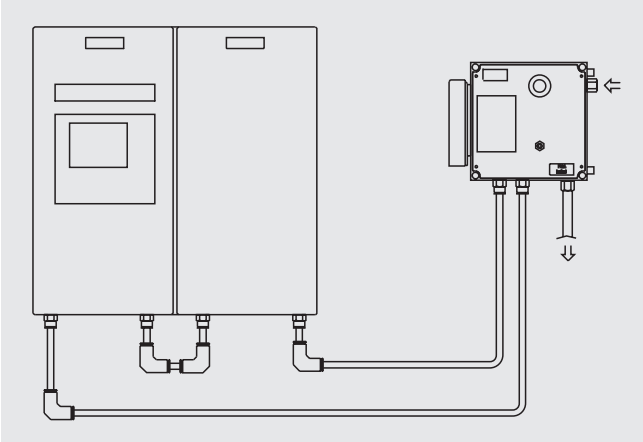


Fig. 22 MiniPurge, gas connections

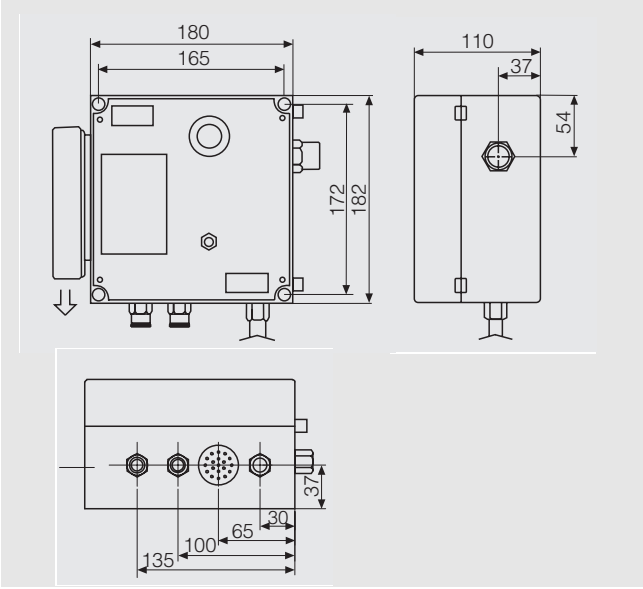


Fig. 23 MiniPurge, dimensions in mm

Technical data

Classification	Class 1 Division 2
Enclosure dimensions (in mm)	444 x 438 x 275
Enclosure volume (l)	Approx. 50 l
Enclosure pressure (normal)	1 hPa
FM certificate	Certificate of compliance 1X8A4.AE / 0B3A3.AE
Reaction upon failure of pressure	Opening of switching contact, and alarm via signal indicator (red display)
System type	MiniPurge complete system
Operating mode	Continuous purging
Type of housing	Strengthened polycarbonate
Enclosure surface	RAL 7035 gray with transparent cover
Pressure supply	Dry, oil-free air or inert gas with regulated pressure of approx. 2000 hPa (30 psi) at inlet of MiniPurge
Supply connections	Pressure via ¼ BSPP connection, pressure hose at least ½" or 12 mm
Display (signal indicator)	Pneumatically driven color signal: green/red
Switching contact	Via SPCO switch approved for Class 1 Division 2
Settings	Lower operating limit 0.5 hPa set relative to purging gas flow of 1 to 2 l/min
Pre-purging time	Is defined by operator, and controlled manually
Enclosure pressure limitation	By means of stainless steel RLV 25 output valve with integral flame inhibitor; opens at 10 hPa ± 10 %

Spare parts

Proposition of spare parts for a 2-year service

Ordering data

Description	Order No.
Analyzer section	
Sample cell without enclosure and piping	**A5E00095332**
O-ring set (FFKM)	**A5E00124182**
Electronics	
Fuse T 0.63 A (230-V version)	**W79054-L1010-T630**
Fuse T 1.0 A (115-V version)	**W79054-L1011-T100**
Front panel without LC-display	**C79165-A3042-B508**
LC-display	**W75025-B5001-B1**
Adapter board LCD/keyboard	**C79451-A3474-B605**

Catalog extract	Order No.
CALOMAT 6 Wärmeleitfähigkeits-Gasanalysator (German)	**E86060-K3510-B181-A2**
CALOMAT 6 Thermal Conductivity Gas Analyzer (English)	**E86060-K3510-B181-A2-7600**
CALOMAT 6 Analyseur de gaz à conductibilité thermique (French)	**E86060-K3510-B181-A2-7700**

Manual	Order No.
CALOMAT 6E Wärmeleitfähigkeits-Gasanalysator (German)	**A5E00123066**
CALOMAT 6E Thermal Conductivity Gas Analyzer (English)	**A5E00123067**
CALOMAT 6E Analyseur de gaz à conductivité thermique (French)	**A5E00123068**
CALOMAT 6E Analizzatore di gas a conductività termica (Italian)	**A5E00123069**
CALOMAT 6E Analizador de gases por conductividad térmica (Spanish)	**A5E00123070**
ULTRAMAT 6, OXYMAT 6, OXYMAT 61, CALOMAT 6, ULTRAMAT 23 Schnittstelle/Interface PROFIBUS-DP/-PA (German and English)	**A5E00054148**

Conditions of sale and delivery
Export regulations, contact addresses

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