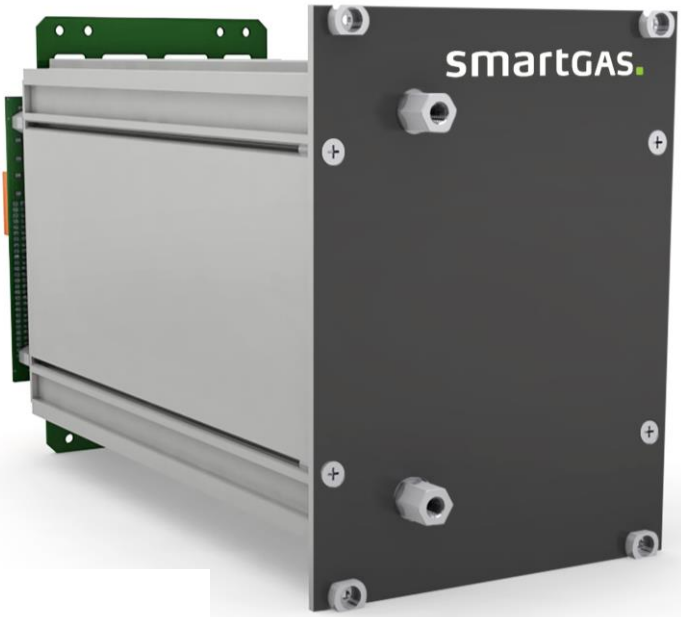
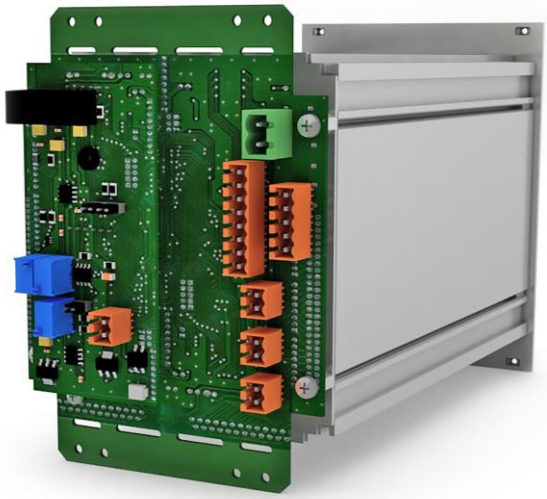
PAS
Photoacoustic Sensor

Description of Module
and Communication for Firmware
Release 2.2





Revision history

Release 1.0	April 2012	
Release 2.0	February 2018	Redesign of unit
Release 2.1	June 2020	Change of data stream
Release 2.2	March 2021	User Interface added

CONTENTS

1. General Instructions

1.1 Indications

This manual contains important information for the operation of **PAS** photo acoustic sensor.
To assure operator safety and the proper use of the instrument, please read, understand, and follow the contents of this manual.

Non-observance of these instructions can result in personal injury or death. Non-observance of these instructions may also lead to the loss of right to claim for damages or warranty!	

Meaning of signs used in this instruction manual:

CATCHWORDS appear in italics on the right hand margin

 : Indication of particular importance

 : Warnings

Please follow the instructions given. Warnings denote a potential hazard associated with the use of **PAS** instrument.
Non-observance of warnings can result in personal injury or damages to the instrument.

 : Avoid actions marked with this sign

Please follow the instructions given. This symbol denotes potential hazard associated with the use of **PAS** instrument. Non-observance of the instructions can result in personal injury or death.

1.2 Safety Precautions and Important Instructions for Operation of PAS

The **PAS** is designed for monitoring concentration levels of certain gases upon customer's request.

The **PAS** instrument is not designed for use in potentially explosive environments. Never place and operate the instrument in areas with a potentially explosive atmosphere!

The instrument should be used only for this field of application and should be installed only by qualified personnel.

2. Description of Sensor Unit PAS

2.1 Instrument layout

2.1.1 Front view

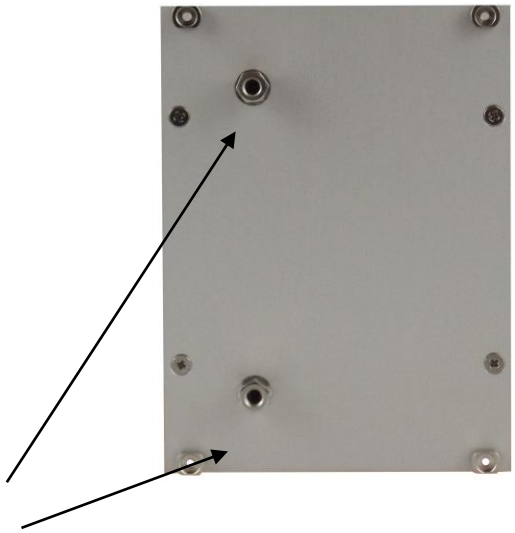


Fig. 1 Front View

1 gas inlet or outlet for fittings with M5 thread

2.1.2 Side view

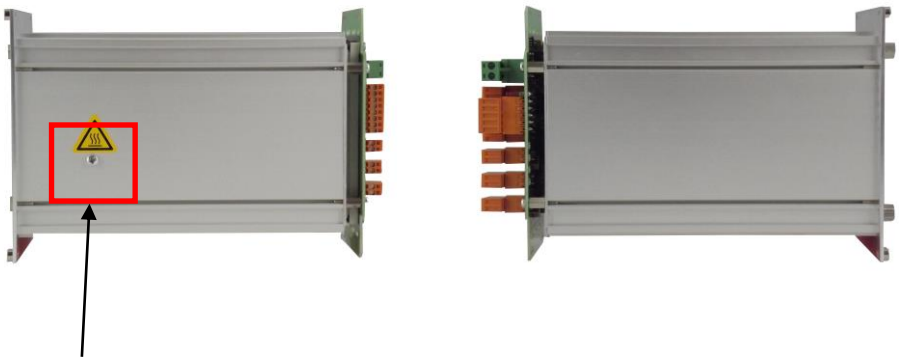


Fig. 2 Side View

1 hot area, to be cooled with automatic controlled fan

2.1.3. Rear View

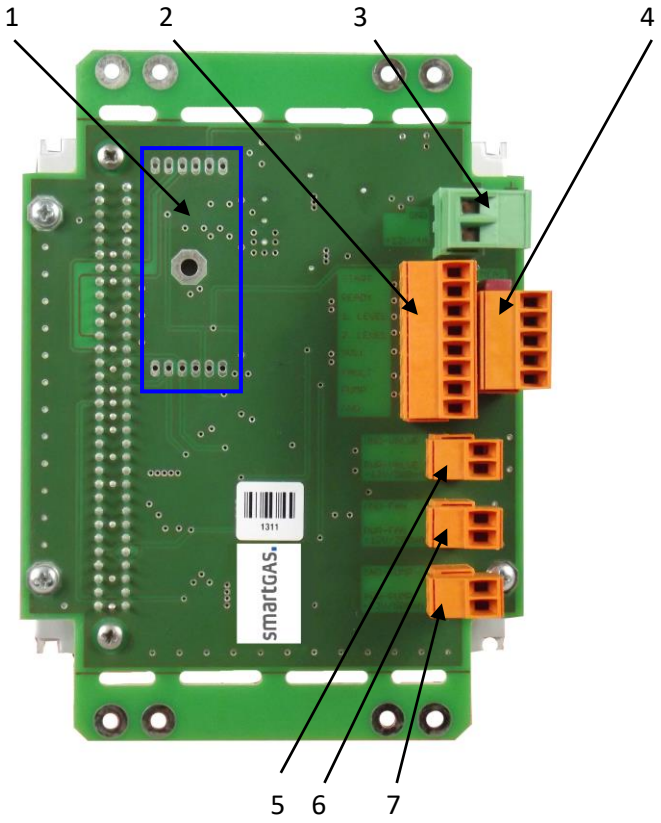


Fig. 3 Rear View

1 Optional circuit board 4-20mA or 0-10 V analog output
2 Digital I/O-connector
3 Main power supply connector
4 Serial communication connector
5 Power connector for external zero gas valve (12V / 500mA)
6 Cooling Fan power connector (12V / 200mA)
7 Pump power connector (12V / 500mA)

2.2 Description of function

2.2.1 Description of instrument function

In the **PAS** a measurement cell is used which operates on the principle of Infrared - Spectrometry.

PRINCIPLE

The physical quality of many gases to react to electromagnetic waves (for instance infrared rays) is being exploited as they respond to a single (or to several) wave length(s) specific to every kind of gas as well as they absorb such energy.

This effect is converted into electric signals by a measuring transducer.
The concentration of the gas component is being calculated via calibration functions filed in the instrument configuration library.

2.2.2 Description of equipment function

The instruments of type **PAS** are equipped with one gas sampling inlet, which may be controlled either automatically by the equipment software or by an external control unit (e.g. plant control). Two limiting values (alarm levels) may be set separately in correspondence to existing requirements. For measurement of the concentration the gas to be analyzed must be drawn into the sensor by e.g. a pump (active sample extraction). During the measuring process a large number of measured values are being integrated. The resulting values transmitted via the serial interface and compared to the limiting values set.

A complete measuring cycle takes about 20 seconds.
An evaluation of the comparison: limit values vs. measured values takes place after a certain delay, preset by the equipment software in order to avoid incorrect readings eventually caused by momentary variations of gas concentration. Mean values are also built only after this delay.

The 1. Alarm level and the 2. Alarm level can be set individually. The alarm signal can be defined as “normally open” (NO), which means HIGH active or “normally closed” (NC), corresponding to LOW active alarm signals. Additionally the two alarm levels can be defined as a window. This function can be used for surveillance of gas concentrations between a minimum and a maximum level.

All for operation necessary functions can be controlled by the instrument or partially by a connected PLC. Due to the fact, that all
I/Os and signals are not galvanic isolated, the instrument can optionally be equipped with a galvanic isolated analog output
(4-20mA or 0-10V).

2.3 Manufacturer-based configuration

For best possible adaptation of instrument to the envisaged task the following parameters of the configuration may be determined by the customer and set at the factory or by authorized service personnel.

• Alarm thresholds	1. and 2. Alarm (in ppm)
• Cyclic zero value measuring	(activated, not activated, time intervals)
• Reference temp. and -pressure	Standard: 0 °C and 1013 mbar
• Time and date	Depending on site

2.4 Technical data

All dimensions +/- 1,27 mm = 0,05 inch

Dimensions:	Standard slide in box fitting in 19” / 3 RU system	
	Height (front plate):	127 mm = 5.0 in
	Width (on front plate):	96,5 mm = 3.8 in (19 HP)
	Depth approx. (excl. analog option):	200 mm = 7.88 in
	Depth approx. (incl. analog option):	210 mm = 8.27 in
Weight:	approx. 1,4 kg = 3.1 lbs	
Power Supply:	External, 12 VDC • 4 Amperes • +/- 1% Stability	
Power consumption:	max. 45 Watts	
Temperature range:	during storage: -10°C to +60°C	(+14°F to +140°F)
	during operation:	+10°C to +40°C (+50°F to +104°F)
Air moisture range:	0 to 95%, non condensing relative humidity	
Measuring principle:	physical, infrared spectrometry, opto-acoustic sensor	
Compound:	Upon customer request	
Measuring range:	Upon customer request	

3. Mounting and Installation

3.1 Mechanical mounting

MOUNTING SITE

In order to assure trouble-free function of the instrument, mounting it as free of vibrations as possible is of essence. The hot area of the module should be kept at a safety distance of at least 5 cm away from walls to ensure free airflow for cooling of the equipment (see also chapter 3.2.2 for reference). The module should be installed out of direct sunlight in a clean, dry area that is not subject to temperature or humidity extremes.	

The instrument has been specified for an ambient temperature range from +10°C (+50°F) up to +40°C (+104°F), provided that a proper fan is installed for cooling the hot side surface (see also chapter 2.1.2). Condensation of air moisture inside the instrument should be avoided. An integrated protection mechanism will switch off the measuring operation if the maximum permissible internal temperature is exceeding a limit of + 55°C (135°F). In this case the instrument will issue a malfunction message.

For cooling purposes the instrument must be set up in such a manner that free circulation of the ambient air is unobstructed. On the other side it must also be protected from exposure to very dusty environment or to splash-water.

FILTERS

For protection of valves and measuring chamber against pollution the gas inlet has to be provided with appropriate filter. The filter must be installed right in front of the sample inlets of the instrument.	

Suitable filters are of such quality that they will neither absorb molecules of the gas components to be measured in the filter housing nor in the filter element itself. Moreover the filtration grade has to be at least 5 micrometers or less. Particle Filters can be ordered from smartGAS Mikrosensorik GmbH.

3.2 Electrical connection

3.2.1 Description of connectors

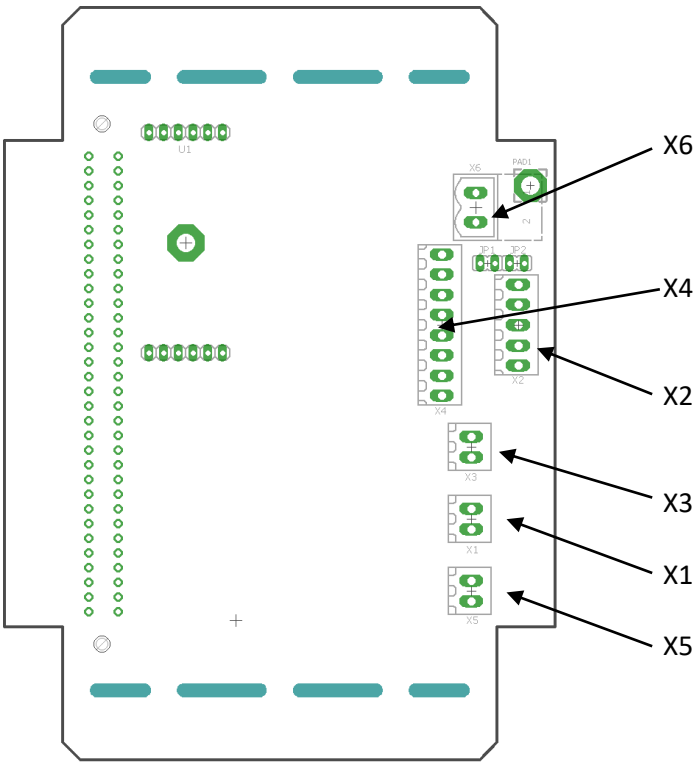


Fig. 12
Electrical connectors / Rear view

X1:	Fan connector (12V / 200mA)
X2:	UART- and I2C-connector
X3:	Valve connector (12V / 500mA)
X4:	Digital I/O for PLC
X5:	Pump connector (12V / 500mA)
X6:	Electrical power input

3.2.2 Electrical Power Connection (X6)

The electrical power supply for **PAS** must meet the following requirements:

Nominal voltage:	12 VDC • 4 Ampere • +/- 1%
Power consumption:	max. 45 watts
EMC:	EN55014 Class B, FCC Part 15 EN55032 Class B

Connection of the instrument to the power supply should be secured with a safety fuse of proper value. If the instrument is external controlled by PLC, the power supply of the PLC should be chosen. Securing the power supply against interfering EM pulses is mandatory!

Always ensure the EMC directive! Unstable power supply or EMC pulses may cause incorrect behaviour and/or readings on the instrument.

Before connecting instrument to electric power verify the supply voltage meets those requirements and is fuse protected. Incorrect voltage may cause the fuse of the instrument to blow or damage the instrument itself.

3.2.3 Digital Input – Output (X4)

The I/O's of **PAS** are intended for signal handling between the instrument and a PLC or plant control.

Logic levels meet the following requirements:

IN logic 0 (low) voltage:	max. 1.0 Volt • max. 1 µAmpere
IN logic 1 (high) voltage:	min. 4.0 Volt • max. 3 mAmpere
OUT logic 0 (low) voltage:	max. 0.6 Volt • max. 1 µAmpere
OUT logic 1 (high) voltage:	min. 4.3 Volt • max. 20 mAmpere

Before connecting instrument to external I/O's verify PLC or plant control meets all requirements. Incorrect voltage or high currents may damage the instrument itself. Level shifters must be used if other input / output voltages are needed / used! The I/O's are not galvanic separated!

Description of instrument's I/O-functions and direction:

Pump (OUTPUT):	Logic 1 when gas should be drawn
Fault (OUTPUT):	Fault of **PAS**
Null (OUTPUT):	Logic 1 when valve switches from zero gas to sample gas
2. Level (OUTPUT):	Second alarm level
1. Level (OUTPUT):	First alarm level
Ready (OUTPUT):	**PAS** is ready for measuring
Start (INPUT):	Start of measuring after zero adjustment (only if instrument is set to external control, see chapter 5.4 and 5.5)

3.2.4 Serial UART Interface (X2)

3.2.4.1 Electrical Characteristics

The instrument is equipped at the factory with a serial UART interface for data transfer. The bitstream is a non inverted TTL-Level of 5Volts. That means, that a logic 1 is represented by a 5V level and therefore a logic 0 is represented by a 5V level.

Description of UART I/O-function and direction:

RXD (INPUT):	Reception of serial data
TXD (OUTPUT):	Transmission of serial data
UART-GND:	Additional ground line for UART

The length of the connecting cable must not exceed 5 meters (16 feet)!	

3.2.4.2 Data Output

The data transfer rate is set to the commonly used 9600 baud, no parity bit, 8 data bit, 1 stop bit (9600,N,8,1).

The data is transmitted without hardware/software handshake!

After each measuring cycle the values are send using the following format:

dd:mm:yy;hh:mm:ss;0000,0;0000,0; ;00000;00.0;0;0;9999; CR

(Date;Time;Value1;Value2; ;Patm;tSensor;C;E;UNIT; CR)

Date / Time	Sensor internal date and time
Value1/Value2	Readout on Value1 in ppm, on Value2 in mg/m³
Patm	Atmospheric pressure [mbar]
tSensor	Sensor temperature [°C]
C	Code for measurement unit on Value1 1 → ppm 2 → mg/m³ 3 → Value1 as ppm and Value2 as mg/m³
E	Error Code / Status Code
UNIT	Unit serial number

Concentrations higher than 999,9 (999.9) will be transmitted without decimal point. Therefore concentrations with more than three digits will be send as whole numbers without decimals.	

The error code is masked by ASCII code, starting with 65, what is an '**A**'.
If an error occurs, the Value1 and Value2 will be marked with '**999999**' and the E-field will be filled with one of the following codes:

Status codes, translation

H: 'Sensor Heat Up'
Z: 'Zero Point Adjustment'

Error codes, translation

A: '- not applicable-'
B: 'Infrared source defective'
C: 'Chopper motor blocking'
D: 'Sensor heater out of range'
E: 'Zero setting unstable'
F: 'Error Factory Calibration'
G: '- not applicable -'
I: 'Cell Temperature out of range'
L: 'Error Configuration-Data'

During normal operation the error code is '0' (Zero)

A more detailed description of the error code can be found in Chapter 6.

Example of transmitted values:

01.09.2012;13:45:07;00000.0;00000.0; ;00963;49.5;3;0;2145; *CR*
01.09.2012;13:45:27;00013.7;00035.5; ;00963;49.6;3;0;2145; *CR*
01.09.2012;13:45:47;00097.2;00251.9; ;00963;49.5;3;0;2145; *CR*
01.09.2012;13:46:07;00126.6;00328.1; ;00963;49.6;3;0;2145; *CR*
01.09.2012;13:46:27;0002455;0006361; ;00963;54.4;3;0;2145; *CR*
01.09.2012;13:46:27;9999999;9999999; ;00963;55.8;2;I;2145; *CR*

In the example above the atmospheric pressure is 963 mbar. The instrument's temperature is about 49.6 °C. **PAS 2540-06** is sending the concentration data in on Value1 in ppm, on Value2 in mg/m3 and on the last send data a cell temperature fault occurs. The serial number of the unit is 2145.

3.2.4.3 Data Input

The **PAS 2540-06** accepts commands to trigger a zero-point adjustment or set a factor in case of shifted readout.

Sending an "Z" (without CR and/or LF) will force a zero-point adjustment. It may take up to 15 seconds until the sensor responds to the command. The sensor will open the measuring cell valves for 20 seconds to let the sensor cell be flushed with zero gas. Further more a directly connected pump and/or zero gas valve may be activated.

The result of the zero-point adjustment will be stored in the internal memory (see **Chapter 5.3** for details of zero-point adjustment)

Example of transmitted values:

String send by user:
Z
Response of sensor:
01.09.2012;13:45:07; ; ; ;00963;49.5;3;Z;2145; *CR*

In case the readout of the sensor is shifted compared to a proper calibration gas, a factor on the internal calibration function can be applied.

By sending “F?” (without CR and/or LF), the sensor will answer with the currently set calibration factor. A new factor may be set by sending “Fx.xxx” (where x is a number, without CR and/or LF).

After transmitting the new factor, the sensor will echo the send string to confirm the active value.

The factor may be within 0.1 as lowest value and 2.0 as highest value. Lower or higher values will be ignored and the sensor answers with “Error”.

Examples of transmitted values:

String send by user:
F?
Response of sensor:
1.000*CR*

String send by user:
F0.999
Response of sensor:
0.999*CR*

String send by user:
F2.0
Response of sensor:
2.000*CR*

String send by user:
F2.1
Response of sensor:
Error*CR*

The factor will be stored in the internal memory and take in effect immediately.

3.2.5 Direct control of accessory (X3 – X1 – X5)

Direct control of accessory through **PAS** (see chapter 3.4 – minimum connection).

X3 (Valve):	2/3-way valve for switching from zero-gas to sample-gas (12V / 500mA)
X1 (Fan):	Fan for cooling the hot area (see chapter 2.1.2)
X5 (Pump):	Pump for gas sampling (12V / 500mA)

3.3 Sample gas connection

The module has one sample gas inlet and one sample gas outlet (refer also to **Chapter 2.1.1**.

The sample gas inlet can be equipped with gas tubes of length up to 120 meters without disturbance of the instruments function. On the sample gas outlet also tubes of length up to 120 meters can be connected (provided that the tubes have an inner diameter of at least 4 mm [approx. 0.16 inch]). An appropriate gas pump must be installed at the gas outlet. A maximum gas flow of approx. 2 liters / minute is recommended. Because of the sensor principle, the measurement cell must be closed for measurement. During measurement the pump can be switched off. This may be done by using the connection X5 for direct control of the pump by the instrument itself (see **Chapter 3.2.6**). If the pump is running free, a bypass between gas inlet and gas outlet must be provided to assure the uninterrupted function of the pump and allow gas sampling, even when the measurement cell is closed for measurement.

To avoid clogging of the inlet valves and soiling of the measurement chamber the sample gas hose must be connected to a particle filter which is installed directly in front of the sample gas inlet of the instrument.

Wrong installation of filter and undue extension of maintenance intervals will inevitably lead to malfunctions or to damages on the instrument!

In order to avoid pollution of valves and of measuring chamber, the instrument may only be operated with adequate filters. The filters are to be placed right in front of the sample gas inlet of the instrument.

Applying the filter protects the instrument against pollution. Suitable filters are of such quality that they will neither absorb measurable gas components in the filter element nor in the filter housing. As an additional feature the filters must permit the filtration of particles size 5 micrometers.

Take utmost care to prevent liquids from penetrating into the measuring chamber. Equally important is the avoidance of humidity condensation in the measuring cell. Any such event will immediately lead to the destruction of the sensor system!

3.4 Example of operation

PAS can be connected to a PLC or plant control by many ways. Following two examples show a minimum connection with direct control of accessory by the instrument itself and a full connection with accessory control via PLC.

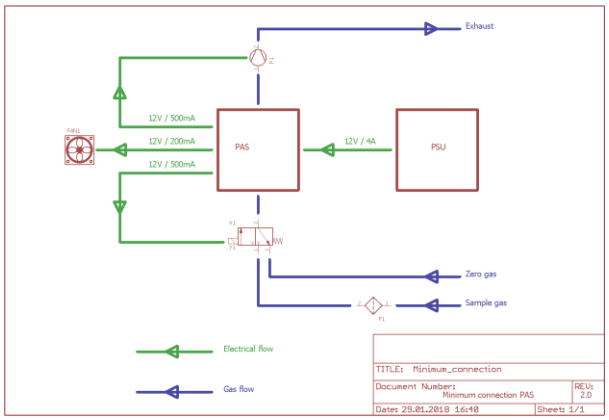


Fig. 4 minimum connection

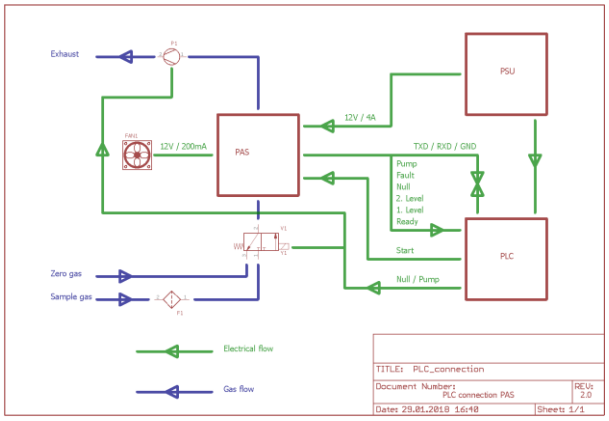


Fig. 5 PLC or plant connection

FAN1:	Fan for cooling of hot area
P1:	Pump for gas transport
V1:	Valve for zero gas / sample gas
F1:	Particle filter
PSU:	Power supply unit
PLC:	Plant control

4. Start of operation

Before connecting the instrument to the power supply, make sure that supply voltages strictly correspond to the requirements detailed in **Chapter 3.2.2**.

As soon as the instrument is powered up, it will start with normal operation (see chapter 5).

5. Operation

After the instrument has powered up, it will automatically run through the following routines before starting the regular measuring operation:

- **Self-Test**
- **Warm-up period**
- **Auto-zero adjustment**

During the startup-process the 'Unit Ready' signal (see **Chapter 3.2.3**) is logic zero.

5.1 Self-test of instrument

Immediately after the instrument is powered up, a self-test is performed.

During the warm-up period and also while in normal operation (except while in Stand-By-Mode) the instrument will carry out periodically automatic self-tests to check important instrument functions. In case of any malfunction, the warm-up period or the actual measurement cycle will be interrupted with a fault signal as logic one (see **Chapter 6,** - Malfunctions). In case of an instrument malfunction, a restart of the instrument is necessary.

5.2 Warm-up period

The measuring chamber of the instrument is being heated up until 49.3°C (120.7°F) has been reached. This will take approximately 5 minutes at an ambient temperature of 20°C (68°F).

After 49.3°C (120.7°F) has been reached, leveling of temperature is being continued a certain time period ('stabilizing') in order to make sure that the whole unit has adopted the desired operating temperature.

The stabilization is an important point for the accuracy of the sensor. Stabilization-time is set at the factory or by authorized service personnel and can vary between 2 minutes up to 10 minutes (depending of required accuracy and compound).

At the end of the stabilization phase the unit starts the zero adjustment procedure.

5.3 Zero adjustment

Repetitive zero adjustment will compensate possible changes in the sensor equipment (e.g. aging of infrared source) and eliminates zero drift. Zero gas must be provided through the sensor and is measured in the cell. An installed 2/3-way valve can be used to switch between zero gas and gas to be analyzed. The valve can be directly controlled by the instrument (see **Chapter 3.2.6**).

Alternatively a properly serviced zero filter (e.g. activated carbon) can be used to supply zero gas. The filter absorbs the measurable substance(s), therefore concentration of substance(s) in the sensor equals to zero (as long as the substance(s) can be absorbed in activated carbon).

A zero measurement in a contaminated atmosphere leads to false measured values!

To provide error-free zero adjustment, the activated carbon filter must be changed regularly. Used-up activated carbon filters will lead to incorrect measurement results or to error condition!	

Only under the condition that a predefined amount of **consecutive zero adjustment cycles** are within a specified tolerance, the zero value will be accepted. In case a measured value exceeds the specified tolerance (caused e.g. by a contaminated measuring chamber or by leaks etc.) the number of hitherto measured values will be reset to zero. **PAS** will then renew its effort for zero adjustment.

If after 50 attempts no values are correct, the instrument will stop zero adjustment and indicate a failure (see **Chapter 6**).

Duration of Zero Adjustment

Duration of zero adjustment for every internal measuring range is approx. 2 minute in a favorable case. In the most unfavorable case this operation may take up to 15 minutes if e.g. the gas path or the measuring chamber is contaminated. If no correct zero adjustment is being achieved within this time frame, then a failure indication will be given (see **Chapter 6**).

After successful zero adjustment the instrument normally switches to "Stand-By-Mode", if neither an automatic measurement channel is configured nor a measurement is externally requested.

Automatic Zero Adjustment

PAS automatically carries out a zero adjustment procedure after every startup. Additional an automatic zero adjustment can be activated in the instrument setup. After a fixed time interval **PAS** automatically performs a zero adjustment and switches back to measurement by itself. Possible time intervals for automatic zero adjustment are 1 – 2 – 4 – 8 – 12 – 16 – 24 hours of measurement.

Manual Zero Adjustment

In those cases where **PAS** has been in operation over a period of more than 5 days **without interruption** and only low gas concentrations are to be measured, a manual zero adjustment is recommended (if no automatic zero adjustment is configured).
The user may trigger such manual zero adjustment by shutting off the power supply for a few seconds.

5.4 Externally controlled measurement operation

After successful zero adjustment the instrument switches to ”Stand-By”-mode.

No measuring is being done.

While the most components are fully available at this stage, the infrared source, the chopper motor and the pump (if connected to the extended output of the instrument) are switched off for optimization of their service life. Therefore the instrument will resume measuring about 30 seconds after receipt of a measurement request. Because of the need for stabilization of the infrared source, the measurement results may show some little inaccuracy during the first 2-3 minutes after leaving stand-by mode.

In “Stand-By”-mode **PAS** is waiting for a measurement request. This request will be sent to the instrument via the digital I/O-connector (for reference see **Chapter 3.2.3**).

5.5 Internally controlled measurement operation

After successful zero adjustment the instrument automatically switches to measuring mode.

An installed 2/3-way valve will switch to the channel with the gas to be analyzed and the pump will periodically start drawing gas.

5.6 Bypassed measurement operation

The sensor can be used in bypass to an existing gas flow. In this setup care must be taken to not apply too much over- or underpressure on the sensor on the one hand and still have a sufficient gas flow through the measuring cell on the other hand.

The user is responsible to only trigger a zero point adjustment if proper zero gas is connected and has sufficient flushed the gas path to remove any residues of analyzed gas. Otherwise the new zero point may be not correct (see Chapter 5.3).

5.7 Measurement process

REFERENCE CONDITIONS

The measuring results for mass concentration are normalized to a reference temperature of 0°C (+32°F) and to an atmospheric pressure of 1013 mbar (14.69 psi) by factory setting. Other reference temperatures and -pressures may be preset in the factory. The actual atmospheric pressure on site is being measured inside the instrument and used for normalization of the measured values.

MEASURING CYCLE

Each measurement cycle consists of the following consecutive steps:

1. The measurement cell is being flushed with actual measuring gas for about 5 seconds (depending on settings).
2. Then the instrument goes on hold for about 3 seconds (depending on settings) to let gas pulsation calm down.
3. Now the measurement is carried out. The result of the measurement is a mean value over quite a number of single measurements.
4. The measurement result is being compared with the preset alarm threshold values.

   If the result exceeds (or under runs, depending on configuration) the 1. Alarm level or the 2. Alarm level, the corresponding output is being activated (please refer to Annex A2 for further information).

6. Operational Failures

6.1 Description of error codes – UART-Interface

Messages about errors are send through the built-in UART-Interface. Simultaneously the signal ALARM will be set to alarm condition (level depending to configuration (NC or NO). In case of a malfunction the operation of the instrument can not be continued right away.

6.1.1 Failure messages

Failure messages indicating that a direct return to normal operation is not possible. The instrument must be switched off. After successful elimination of the failure cause the module may be switched on again for normal start-up procedure.

WARNING! HIGH VOLTAGE!

Prior to opening up of instrument for any reason, its main power supply must be unplugged! Non-observance of these instructions can result in personal injury or death.

"IR-Source" – Code "B"
Explanation:
Evidently no power consumption at infrared source

Probable causes:
- Electronic control defect
- Infrared source defect
- Transportation damage (filament broken)

Corrective action:
- Exchange measuring cell (manufacturer)

"Chopper" – Code "C"
Explanation:
Chopper motor blocked or no movement

Probable causes:
- Electronic control defect
- Motor defect
- Transportation damage (chopper wheel bend)

Corrective action:
- Exchange measuring cell (manufacturer)

"Sensor heater" – Code “D”
Explanation:
Ambient temperatures lower than 10° C resp. 58°F or
ambient temperature higher than 40° C resp. 104°F.

Probable causes:
- Instrument or ambient temperature is outside of the operating parameters.

Corrective action:
- At occurrence of this error message, it should at first be checked if external influences are causing this critical situation, and if applicable, eliminate those negative influences.
- In case error message was not caused by external influences, defect module should be send to service (manufacturer).

"Zero setting unstable" – Code “E”
Explanation:
Sensor unable to conform preset value within determined tolerances during zero setting.

Probable causes:
- Zero-gas unstable or filter used-up
- Measurement chamber leakage at inlet/outlet gate valve because of insufficient dust filtration or excessive suction (higher than 50 mbar = 0.7 psi)
- Excessive suction may also be caused by tube lengths exceeding permissible length.

Corrective action:
Replace zero-gas or filter. If problem re-occurs, exchange of measuring cell is required (manufacturer).

Incorrect installation of filter and undue extension of maintenance intervals will cause malfunctions or damages of measuring instrument.

"Cell temperature" – Code “I”
Explanation:
Sensor temperature higher than 55° C resp. 119°F

Probable causes:
- Instrument is directly exposed to external heat sources (inadequate ventilation, high solar radiation, problematic installation site).
- Blower-fan (or fan control) defect
- Electronic control of heater defect

Corrective action:
- At occurrence of this error message, operator in charge should at first check if external influences are causing this critical situation, and if applicable, eliminate those negative influences.
- In case error message was not caused by external influences, defect module should be send to service (manufacturer).

"Error CFG-Data" – Code “L”

Probable causes:
- Defect in data-/program - memory or manipulated data

Corrective action:
- Servicing required. Send instrument for repair

6.2 Communication problems between instrument and external control

Below some malfunctions are listed which may occur during communication between external control and the **PAS**.

6.2.1 Errors caused by external control

- **No reaction of instrument**
  In case the signal „**START**“ has not been set by the external control, instrument will not react to any requests for measurement. This is only applicable if the instrument is set to external control (see Chapter 5.4, externally control)

6.2.2 Error on digital I/O cable

- **No reaction of instrument**
  Broken wires on interface cable or on plug

6.2.3 Error on PAS I/O-module

- **No reaction of instrument even if results remain below limit**
  In case the instrument does not evaluate results respectively does not react on signal, although at control side the control signals are found to be correct, measuring time should be extended. If situation is not improved thereby, verify if result signal outputs (Alarm 1 / Alarm 2) are properly connected at control side. If this is found to be correct, the interface cable should be inspected for possible wire damage. In case no defect is found on cable either, the interface bus module has to be replaced (manufacturer).

7. Maintenance

7.1 General hints

The instrument has been designed for optimum maintainability. A skilled user may perform all conditioning maintenance work himself if required.

CLEANING

The instrument housing may be cleaned with a smooth cloth which has been wetted with water and only a few drops of cleansing agent.

Never use organic solvents (e.g. PERC, TRI, Acetone).Organic solvents may be harmful to the instrument.

7.2 Exchange of sample gas filters (particle filter)

Appropriate sample gas filters are of such nature as they will neither absorb molecules of the sample gas components in the filter element nor in the filter housing. Furthermore must they permit filtration of 5 micrometer particle size.

In order to avoid contamination of valves, of sample gas hoses and of the measuring cell, the instrument should exclusively be operated using genuine particle filters supplied by smartGAS Mikrosensorik GmbH! **The filters must be installed right in front of the sample inlet of the instrument.**

When changing sample gas filters, proceed as follows:

- In order to avoid contamination of sample- gas tubing during changing of filters, switch off instrument.
- Unscrew the dust filter screw caps.
- Insert the new dust filter. A label attached to it is showing an arrow indicating the flow direction of sample gas.

The arrow must point towards instrument gas inlets!	

- Write down actual calendar date on filter label. This allows easy control of filter-change schedule.

We recommend exchanging particle filters every 3 months.	

7.3 Calibration of Instrument

The instrument-integrated functions concerning avoidance of zero- drift are described in Chapter 5.3 of this instruction manual.	

For re-calibration of the **PAS** a special software is necessary. For reference get in contact with your local dealer or smartGAS Mikrosensorik GmbH.

In case of availability of adequate equipment the calibration may be done by authorized service personnel under adherence to the appropriate safety rules.

A factory calibration is required every 24 months. The calibration normally is done besides complete instrument maintenance.

8. Options

8.1 Analog-outputs

8.1.1 Options V218 - analog recorder output 4-20 mA / 0-10 V

When option V218 is installed, **PAS** is equipped with a galvanic separated current or voltage output circuit board.

Resolution of the output current/voltage is dependent on sensor type installed. During warm-up period and zero adjustment the recorder output is set to 4 mA. This corresponds to a concentration of 0 ppm (g/m^3). During actual measuring the recorder output is set - prior to every pump cycle - to the current which corresponds to the actually measured concentration. If an underflow of the measuring range occurs, the output is set to the current value which corresponds to the lower limit of the measuring range.

The total measuring range is scaled on 4 mA to 20 mA or 0 V to 10 V.

9. Legal Information

The figures and drawings used in this description may differ from the originals; they are provided solely for illustrative purposes.
All information – including technical specifications – is subject to change without notice.

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