IAQ Indoor Air Quality Detector BIO 2000

Metal Oxide Air Quality (VOC) Detector

User Manual

October, 2011

Detector for Air Quality (VOC) with Metal Oxide Semi-conductor Sensor

1 Intended Use

The AP analog/digital detector BIO 2000 with digital processing of the measuring values and temperature compensation is used for measuring the air quality and the temperature in indoor areas.

The intended sites are all areas being directly connected to the public low voltage supply, e.g. residential, commercial and industrial ranges as well as small enterprises (according to EN50 082).

The BIO 2000 analog/digital detector must not be used in potentially explosive atmospheres. The detector must only be employed in areas within the environmental conditions as specified in the Technical Data.

2 Functional Description

2.1 Control Mode

In addition to the analog output the detector is equipped with a serial interface RS-485 for the connection to the CGD-05 system.

Analog mode:

The analog output can be selected as current signal with (0)4-20 mA or as voltage signal (0)2-10 V.

CGD-05_Bus mode:

The detector can be connected to the CGD-05 system via the RS-485 interface. In this mode there is an analog input for the connection of an additional 4-20 mA detector. The two measuring values are transmitted via the RS-485 interface to the gas controller.

The cable topology for the RS-485 bus can be taken from the “Guidelines for wiring and commissioning of the CGD-05 hardware”.

ModBus mode:

The detector can be connected via RS-485 interface / ModBus protocol to different devices like, DDC, SPC, BMS, PC etc. as a central unit. In this mode there is an analog input for the connection of an additional 4-20 mA detector. The two measuring values are transmitted via the RS-485 interface / ModBus protocol.

The cable topology for the RS-485 bus can be taken from the “Guidelines for wiring and commissioning of the CGD-05 hardware”.

The analog mode is available in parallel to the CGD-05 bus mode or the ModBus mode.

2.2 VOC Sensor

The semi-conducting metal oxide sensor measures the electrical conductivity of the nanocrystalline metal oxide coated on a heatable substrate. The typical operating temperature is between 300 and 400 °C. The doping of the metal oxide with noble metals results in a positive sensibility to combustible gases like VOCs, carbon monoxide and natural gas. The doping permits the adaptation to the demands of the measuring task. VOCs are partially or totally burnt at the sensor surface by the oxygen of the metal oxide. The electrons released in the semi-conductor by this process lead to an increase of the electrical conductivity. At the end of the combustion process, the metal oxide returns to its initial state by incorporating oxygen from the air, with the conductivity also adopting the initial value. The change of the conductivity is evaluated via the internal micro-controller and output as a standard signal.

2.3 VOC Measurements

The VOC content in indoor areas is mainly determined by the persons present and their activities. See table 1. When for example working with cleaning agents or when cooking, VOCs (Volatile Organic Compounds) are set free, but also human respiration is a constant source of volatile metabolism products (VOCs). The air quality sensor detects the increasing VOC level and calculates the proportional CO_2 value. The VOC/CO_2 correlation was determined by taking measurements under real conditions. See diagram 1.

To this day, there aren't any standard signals for the VOCs; therefore the IAQ air quality sensor reduces the measured VOC values to CO_2 equivalents with the unit ppm. This grants the compatibility to existing CO_2 ventilation standards.

Each time the IAQ air quality detector is switched on, it runs through a warm-up period of 20 minutes. During this warm-up period there aren't any measurements; the sensor outputs the signal of 80% of the measuring range.

After the warm-up period, the sensor interprets the currently read VOC value as zero-point, independently from the actual concentration. An internal algorithm continuously updates the zero-point by taking the lowest measured VOC value. Therefore the ambient air should be of low VOC content after the warm-up period. This can be obtained by shortly venting when starting the measurements with the 80% signal.

If the sensor isn't started at low VOC concentrations, it can take a couple of days until the internal algorithm has updated the zero-point so far that effective measuring results are available.

The natural sensor drift and ageing is corrected by the implemented control algorithms.

Indoor Air		Typical Substances		Ventilation
Contamination Source	Emission Source	VOCs	Others	
Human Being	*Breath	Acetone, Ethanol, Isoprene		demand controlled
		CO2		
		Humidity		
	*Skin respiration & transpiration	Nonanal, Decanal, α-Pinene		
		Humidity		
	*Flatus	Methane, Hydrogen		
	*Cosmetics	Limonene, Eucalyptol		
	*Household Supplies	Alcohols, Esters, Limonene		
	*Combustion (Engines, Appliances, Tobacco Smoke)	Unburnt Hydrocarbons		
		CO		
		CO2		
		Humidity		
*Building Material *Furniture *Office Equipment +Consumer Products	*Paints *Adhesives *Solvents *Carpets	Formaldehyde, Alkanes, Alcohols, Aldehydes, Ketones, Siloxanes		permanent (5-10%)
	*PVC	Toluene, Xylene, Decane		
	*Printers/Copiers, Computers	Benzene, Styrene, Phenole		

Table 1 – Typical indoor air contaminants (VOC and others)

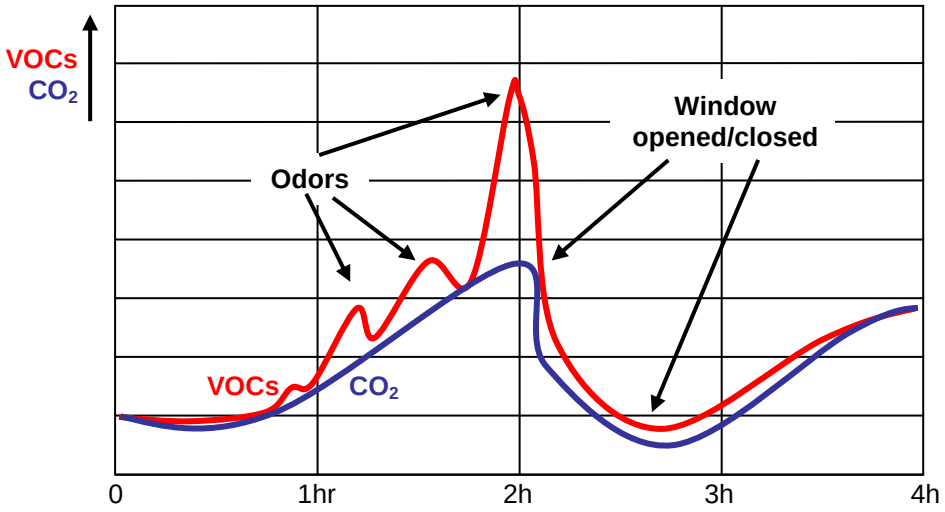


Diagram 1: Correlation CO_2- VOC (records from a business meeting session)

3 Installation

Note: Avoid any force (e.g. by thumb) on the sensor element during operation or installation. Electronics can be destroyed by static electricity. Therefore, do not touch the equipment without a wrist strap connected to ground or without standing on a conductive floor (acc. to DIN EN100015).

3.1 Mounting Instructions

When choosing the mounting site please pay attention to the following:

- **Recommended mounting height is 1.0 m (3 feet) to 1.5 m (5 feet) above floor or lower depending on gastype.**
- Do not mount the detector next to doors, windows, air inlets and outlets.
- Free air supply must be granted.
- Vertical mounting (air inlet at the detector down/up)
- Avoid direct sunlight.
- No heat sources around in case of temperature measurement.

Duct mounting

- Mount only in a straight section of duct with minimum air vortex. Keep a minimum distance of 1 m (3.5 feet) from any curve or obstacle.
- Mount only in a duct system with a maximum air velocity of 10 m/s (2000 ft/min) or less.
- Mounting must be performed so that the probe openings are in line with the airflow.

3.2 Installation

- Open the cover. Unplug basic PCB carefully from the bottom part.
- Fix bottom part by screws vertically to the wall (terminal blocks to the ground).
- Plug in the basic PCB at X4 and X5 with care. Replace the cover.

4 Electrical Connection

Consider static electricity! See 3. Mounting

- Installation of the electrical wiring should only be executed by a trained specialist according to the connection diagram, without any power applied to conductors and according to the corresponding regulations!
- Avoid any influence of external interference by using shielded cables for the signal line, but do not connect the shield.
- Recommended cable for analog mode: J-Y(St)Y 2x2x0.8 LG (20 AWG), max. loop resistance 73 Ω/km (20.8 Ω/1000 ft).
- Serial Interface Mode:

  Required cable for RS-485 mode: J-Y(St)Y 2x2x0.8 LG (20 AWG), max. loop resistance 73 Ω/km (20.8 Ω/1000 ft)

  When selecting and installing the cables you have to comply with the regulations concerning the RS 485 bus installation. The installations have to be executed in line topology. Cable length and type have to be considered as well.
- It is important to ensure that the wire shields or any bare wires do not short the mounted PCB.

4.1 Wiring Connection

- Open the cover. Unplug basic PCB carefully from terminal blocks X4 and X5.
- Insert the cable and connect cable leads to terminal blocks. See fig. 1 and 2.
- Replug the PCB in the terminal blocks X4, X5 with care. Replace the cover.

Note: The connection of the power supply at the output signal (X4 pin 4) can destroy the detector.

5 Commissioning

Consider commissioning instructions at any exchange of the sensor element as well.

Only trained technicians should perform the following:

- Check mounting location.
- Select output signal form: Current or voltage, and starting point 0 or 20%. See fig.5.
- Check power voltage.
- Check PCB SM03-00X for correct mounting at X4 and X5.
- Addressing of the detector in the CGD-05_Bus mode.

Required instruments for commissioning (calibration) of the detector:

- Calibration tool CGD-05 STL (only for addressing with service tool CGD-05).
- CGD-05 configuration and calibration software incl. USB/RS-485 communication set (only for software addressing mode).

5.1 Addressing, only for CGD-05_Bus mode

In the CGD-05_Bus mode each detector gets its communication address.

In the standard version with the communication connector X12, addressing is done by means of the CGD-05 Service Tool or by the CGD-05 Configuration and Calibration Software. See user manual of the Service Tool or of the Configuration and Calibration Software.

In the manual addressing version which can be identified by the address switch being equipped, there is a maximum of 60 addresses to be selected. See fig. 3.

The jumper is responsible to define the address group and the switch to define the address according to the following table.

Switch position	Jumper pos. 01 = address	Jumper pos. 02 = address	Jumper pos. 03 = address	Jumper pos. 04 = address
0	inactive	inactive	inactive	inactive
1	01	16	31	46
2	02	17	32	47
3	03	18	33	48
4	04	19	34	49
5	05	20	35	50
6	06	21	36	51
7	07	22	37	52
8	08	23	38	53
9	09	24	39	54
A	10	25	40	55
B	11	26	41	56
C	12	27	42	57
D	13	28	43	58
E	14	29	44	59
F	15	30	45	60

5.2 Option Relay Output

The two relays are activated in dependence of the gas concentration. If the gas concentration exceeds the adjusted alarm threshold, the corresponding relay switches on. If the gas concentration falls below the threshold minus hysteresis, the relay switches off again.

The contact function for relay 2, NC (normally closed) or NO (normally open), can be selected via the jumper NO/NC. See fig 1 and 3. Relay 1 is equipped with a change-over contact.

Via the ModBus interface the two alarm thresholds and the hysteresis are freely adjustable at the PC within the measuring range. The procedure can be read from the user manual “ModBus Software”.

The following parameters are factory-set.

Alarm threshold 1 = Relay 1: 800 ppm
Alarm threshold 2 = Relay 2: 1000 ppm
Switching hysteresis: 200 ppm

Levels to set up for controlling the air quality by the ventilation system

[ppm]	Air Quality
2100	BAD Heavily contaminated indoor air Ventilation required
2000	
1900	
1800	
1700	
1600	
1500	MEDIOCRE Contaminated indoor air Ventilation recommended
1400	
1300	
1200	
1100	
1000	FAIR
900	
800	GOOD
700	
600	EXCELLENT
500	
400	

Measurement starts at 450 ppm. At 10 volt output signal it becomes approximately 11% at 4800 ppm and 22% at 0 to 2000 ppm.

6 Inspection and Service

Inspection, service and calibration of the detectors should be done by trained technicians and executed at regular intervals. We therefore recommend concluding a service contract with Automatikprodukter or one of their authorized partners.

According to EN 45544-4, inspection and service has to be executed at regular intervals. The maximum intervals have to be determined by the person responsible for the gas warning system according to the legal requirements. Automatikprodukter recommend checking the AP Detector every three months and maintaining it every 12 months. If different intervals are indicated, always consider the shortest interval.

Inspections and services must be documented. The date for the next maintenance has to be affixed to the detector.

6.1 Inspection

The AP Detector should be controlled regularly by a competent person according to EN 45544-4. The following has to be checked in particular:

- Maintenance/ calibration interval not exceeded.
- Visual inspection of the detector including cable for damage etc.
- Remove dust deposits, especially at the gas inlet.
- The filter at the gas inlet has to be replaced if extremely dirty.

6.2 Service and Calibration

When performing the maintenance you have to do the functional test in addition to the inspection.

- Functional test: Check the output signal at the test pins during calibration.

7 Troubleshooting

7.1 Analog Mode

Trouble	Cause	Solution
Output signal < 3 mA / 1.5 V and/or control voltage < 30 mV only for starting signal 2V/4 mA	Jumper 0-20 % not set	Check jumper position
	Power voltage not applied	Measure tension at X4: Two-wire: Pin 1 (+) and 4 (-) Three-wire: Pin 1 (+) and 2 (-)
	PCB not plugged in correctly at X4/ X5	Replug PCB correctly
	Wire break	Check the wiring
Output signal > 22 mA /220 mV	Short-circuit	Check the wiring
No reaction of the output signal in spite of VOC concentration	Power voltage not applied	Measure tension at X4
	Signal (pin 4) not wired correctly	Check the wiring

7.2 CGD-05_Bus Mode

Trouble	Cause	Solution
Yellow LED not shining	Power voltage not applied	Measure tension at X4: Pin 1 (+) and 2 (-)
	PCB not plugged in correctly at X4/X5	Replug PCB correctly
	Wire break	Check wiring
Yellow LED not flashing	No communication at the detector	Detector not addressed, check bus wiring incl. topology and termination Voltage < 16 V
No control voltage at calibration	Jumper V-A not set	Set the jumper. Remove it after calibration!

8 ModBus Specifications

Interface settings

Baud:	9600
Start bit	1
Stop bit	1
Parity	No

Read Register description

Addr.	Function	Notes
0	Sensor type	E.g… BIO 2000 Air-quality (VOC)-detector
1	Versions number	E.g. xXxx = Addressing and calibration via tool
2	Internal sensor measurement value	Value is normalized on the numerical range of 0 to 10.000 Value -10 means sensor error
3	External sensor measurement value	Value is normalized on the numerical range of 0 to 10.000 Value -10 means sensor error
4	Internal sensor measurement value	Value is normalized starting from 0 up to the gas measuring range (e.g. VOC 0- 2000 ppm). Value -10 means sensor error
5	External sensor measurement value	Value is normalized starting from 0 up to the gas measuring range (e.g. CO 300ppm). Value -10 means sensor error
6	Temperature ADC value	Internal temperature value in digits
7	res	For future applications
8	res	For future applications
9	res	For future applications
10	Detector Bus address	Own bus address, e.g. 15 Value range from 1 to 255 The address 245 is defined ex works. When the Selector cable is plugged-in, the sensor reports to address 246, but displays its own stored address. (246 isn't stored and isn't valid any more after plug-out. It is only used to find already addressed devices.) EEPROM value must not be changed continuously.
11	Gain factor	E.g. 10.000 non calibrated ex works, value range 3000 to 30.000
12	Zero offset value	E.g. 0 non calibrated ex works, value range 0 to 1.000 The value of this register is subtracted from the measured value.
13	res	For future applications
14	Full-scale value	E.g. 300 for CO sensor. This value is used for the conversion of the registers 4 and 5 in order to calculate the full-scale value.
15	Relay 1 –Setpoint value	Setpoint level for Relay 1
16	Relay 2 –Setpoint value	Setpoint level for Relay 1
17	Output 3 –Setpoint value	Setpoint level for Output 3 (open Collector X9 pin 1)
18	Output 4 –Setpoint value	Setpoint level for Output 4 (open Collector X9 pin 3)
19	Hysteresis	Hysteresis Value from 0 to Full-scale value
20	res	For future applications
21	res	For future applications
22	res	For future applications

Write Register description

Addr.	Function	Notes
0	Detector B□s address	Own bus address, e.g. 15 Value range from 1 to 255 The address 245 is defined ex works. When the selector cable is plugged-in, the sensor reports to address 246, but displays its own stored address. (246 isn't stored and isn't valid any more after plug-out. It is only used to find already addressed devices.) EEPROM value must not be changed cyclically.
1	Gain factor	E.g. 10000 non calibrated ex works, value range 3000 to 30.000. EEPROM value must not be changed cyclically.
2	Zero offset value	E.g. 0 non calibrated ex works, value range 0 to 1.000 The value of this register is subtracted from the measured value. EEPROM value must not be changed cyclically.
3	res	For future applications
4	Full-scale value	E.g. 100 for Ex sensor. This value is used for the translation of the registers 4 and 5 in order to calculate the full-scale value. EEPROM value must not be changed cyclically.
5	Relais 1 –Setpoint value	Setpoint level for Relay 1 EEPROM value must not be changed cyclically.
6	Relais 2 –Setpoint value	Setpoint level for Relay2 EEPROM value must not be changed cyclically.
7	Output 3 –Setpoint value	Setpoint level for Output 3 (open Collector X9 pin 1) EEPROM value must not be changed cyclically.
8	Output 4 –Setpoint value	Setpoint level for Output 4 (open Collector X9 pin 3) EEPROM value must not be changed cyclically.
9	Hysteresis	Hysteresis Value from 0 to Full-scale value EEPROM value must not be changed cyclically.
10	res	For future applications
11	res	For future applications
12	res	For future applications

9 Technical Data

Sensor data[1]	
Gas type	* VOC (alcohols, aldehydes, aliphatic hydrocarbons, amines, aromatic hydrocarbons, carbon monoxides, methane, LPG, ketones and organic acids)
Sensor element	Metal oxide semi-conductor
Working range	0 – 2000 ppm VOC or 0 – 2000 ppm
Accuracy	± 150 ppm
Repeatability	± 5 % of reading
Response time	t_{90} < 60 s
Warm-up time	20 min.
Sensor life expectancy	> 10 years/ normal ambient conditions
Electrical	
Power supply	18 - 28 VDC/AC, reverse polarity protected (half-wave rectifier input)
Power consumption (without options)	< 1 Watt (average)
Output signal	
Analog output signal (0 – 4000 ppm VOC) Selectable: Current / tension Starting point 0 / 20 %	(0) 4 – 20 mA, load ≤ 500 Ω, (0) 2 - 10 V; load ≥ 50 k Ω proportional, overload and short-circuit proof
D/A resolution	10 Bit, 10 mV
Environmental Conditions	
Humidity	5 to 95% RH non-condensing
Working temperature	0 °C to + 50 °C (32 °F to 122 °F)
Storage temperature	-10 °C to + 50 °C (14 °F to 122 °F)
General Information	
Operating environment	Residential, commercial and industrial ranges
Physical	
Enclosure stainless steel Type 5	Stainless steel V2A
Flammability	UL 94 V2
Enclosure colour	Natural, brushed
Dimensions (W x H x D)	113 x 135 x 45 mm (5.35 x 4.5 x 1.8 in.)
Weight	Approx. 0.5 kg (1.1 lbs.)
Protection class	IP 55
Mounting	Wall mounting, pillar mounting
Enclosure plastic, Type A	Polycarbonate
Dimensions (W x H x D)	94 x 130 x 57 mm (3.7 x 5.12 x 2.24 in.)
Weight	Approx. 0.3 kg (0.8 lbs.)
Protection class	IP 65
Mounting	Wall mounting
Cable entry	Standard 1 x M 20
Wire connection	Screw-type terminal: 0.25 to. 2.5 mm^2 24 to 14 AWG
Wire distance	Current signal ca. 500 m (1500 ft.) Voltage signal ca. 200 m (600 ft.)
Guidelines	EMC Directive 2004 / 108 / EEC
	CE
Approvals	
Enclosure Type A	UL 508A
Warranty	1 year on material (without sensor)

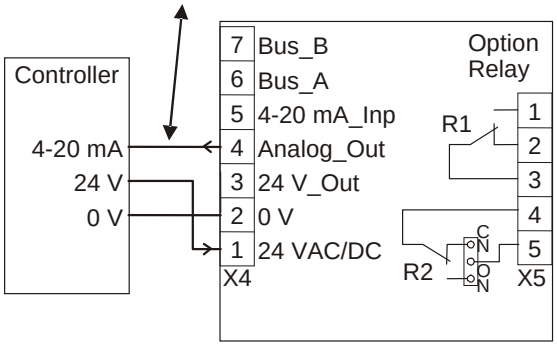
[1] Sensor data only valid for circulating air.

Options	
Relay output	
Alarm relay 1	30 VAC/DC 0.5 A, potential-free, SPDT
Alarm relay 2	30 VAC/DC 0.5 A, potential-free SPNO/SPNC
Power consumption	30 mA, (max. 0.8 VA)
Warning buzzer	
Acoustic pressure	85 dB (distance 300 mm) (1 ft.)
Frequency	3.5 kHz
Power consumption	30 mA, (max. 0.8 VA)
LCD display	
LCD	Two lines, 16 characters each, not illuminated
Power consumption	10 mA, (max. 0.3 VA)
LED indicator	
Green, yellow, red	Power supply, Low- Alarm, High- Alarm
Power consumption	10 mA, (max. 0.3 VA)
Heating	
Temperature controlled	3 °C ±2°C (37.5 °F ± 3.6 °F)
Ambient temperature	- 40 °C (- 40°F)
Power consumption	0.3 A; 7.5 VA
Analog input	
Only for RS-485 mode	4 – 20 mA overload and short-circuit proof, input resistance 200 Ω
Power supply for external detector	24 VAC/DC depending on the power supply max. load 50 mA

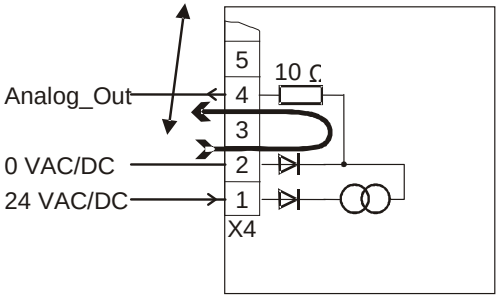
10 Figures

Application: Analog mode
Fig. 1

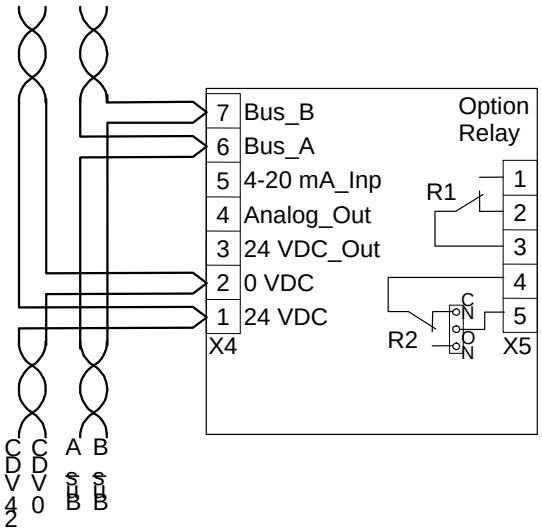
Do not connect power supply at this pin.
(0 VDC, 24 VAC or 0VAC will destroy the detector.)



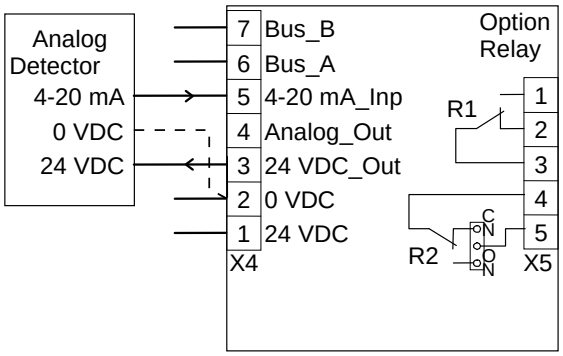
Do not connect 24 VAC at pin 2 and pin 4
or +24 VDC at pin 2 and 0 VDC at pin 4!!
Short-circuit = R 10 Ohm burns up!!



Application: CGD-05_Bus or ModBus mode
Fig. 2

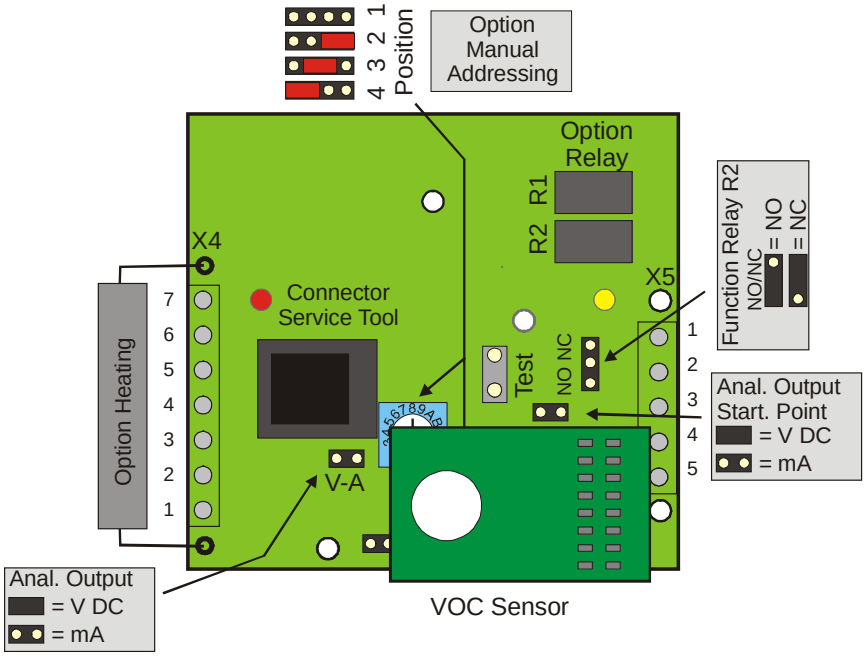


Connection field bus and tension

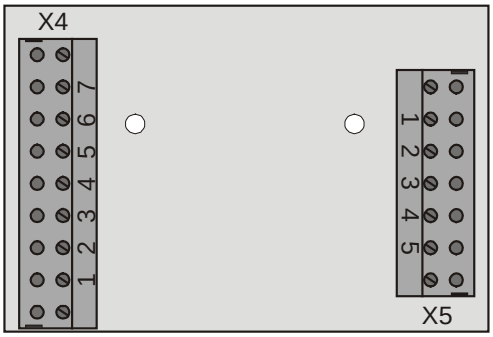


Connection analog detector
- Two- or three-wire connection, depending on detector type

PCB SM03-00X
Fig. 3



Terminal block
Fig. 4



Selection analog output signal
Fig. 5

Jumper 0- 20 %	Jumper V-A	Output signal
Not set	Not set	0 – 20 mA
Set	Not set	4 – 20 mA
Not set	Set	0 – 10 V
Set	Set	2 – 10 V

11 Part Disposal

Since August 2005 there are EC-wide directives defined in the EC Directive 2002/96/EC and in national codes concerning the waste electrical and electronic equipment and also regarding this device.

For private households there are special collecting and recycling possibilities. For this device isn't registered for the use in private households, it mustn't be disposed this way. You can send it back to your national sales organisation for disposal. If there are any questions concerning disposal please contact your national sales organisation.

Outside the EC, you have to consider the corresponding directives.

12 Notes and General Information

It is important to read this user manual thoroughly and clearly in order to understand the information and instructions. The AP® detectors must be used within product specification capabilities. The appropriate operating and maintenance instructions and recommendations must be followed.

Due to on-going product development, Automatikprodukter reserve the right to change specifications without notice. The information contained herein is based upon data considered to be accurate. However, no guarantee is expressed or implied regarding the accuracy of this data.

12.1 Intended Product Application

The AP® detectors are designed and manufactured for control applications and air quality compliance in commercial buildings and manufacturing plants.

12.2 Installers' Responsibilities

It is the installer's responsibility to ensure that all AP® detectors are installed in compliance with all national and local codes and OSHA requirements. Installation should be implemented only by technicians familiar with proper installation techniques and with codes, standards and proper safety procedures for control installations and the latest edition of the National Electrical Code (ANSI/NFPA70). It is also essential to follow strictly all instructions as provided in the user manual.

12.3 Maintenance

It is recommended to check the AP® detector regularly. Due to regular maintenance any performance deviations may easily be corrected. Re-calibration and part replacement in the field may be implemented by a qualified technician and with the appropriate tools. Alternatively, the easily removable plug-in detector card with the sensor may be returned for service to Automatikprodukter.

12.4 Limited Warranty

Automatikprodukter warrant the AP® detectors for a period of one (1) year from the date of shipment against defects in material or workmanship. Should any evidence of defects in material or workmanship occur during the warranty period, Automatikprodukter will repair or replace the product at their own discretion, without charge.

This warranty does not apply to units that have been altered, had attempted repair, or been subject to abuse, accidental or otherwise. The warranty also does not apply to units in which the sensor element has been overexposed or gas poisoned. The above warranty is in lieu of all other express warranties, obligations or liabilities.

This warranty applies only to the AP® detector. Automatikprodukter shall not be liable for any incidental or consequential damages arising out of or related to the use of the AP® detectors.