Indoor Air QualityController IAQH-C

This device is especially designed for the automatic windows of the VELUX company.

User Manual

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Metal Oxide IAQ Indoor Air Quality (VOC) Transmitter

1 Intended Use

The indoor air quality control IAQH-C with digital processing of the measuring values and temperature compensation is used for measuring and controlling the air quality in indoor areas within environmental conditions specified in the Technical Data.

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 indoor air quality control IAQH-C must not be used in potentially explosive atmospheres.

2 Functional Description

2.1 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.

2.2 Air Quality 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 transmitter 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)

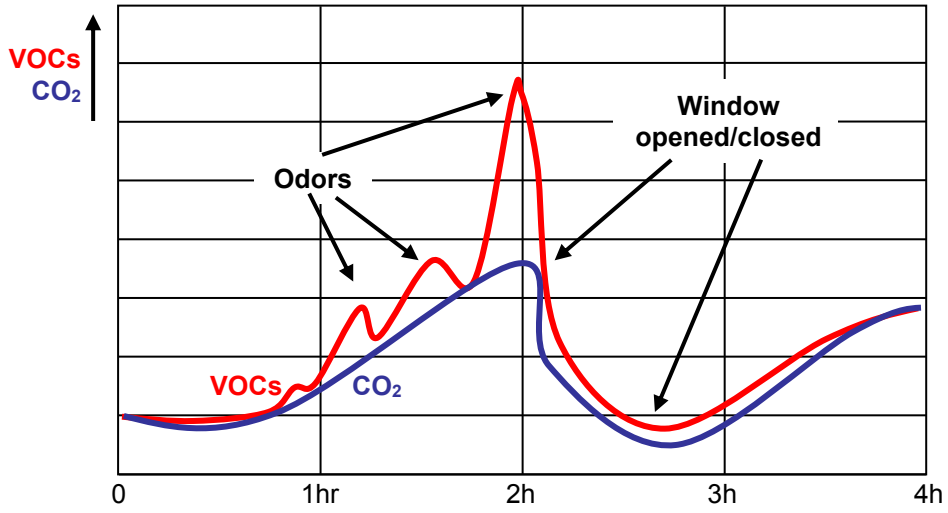


Diagram 1: Correlation CO_2- VOC (records from a business meeting session)

2.3 Temperature Measurement

The temperature measurement is done via an internal sensor. The signal is used as protection against the cooling down of the room and isn't output.

Additional heat sources in the flash-mounted box have an influence on the temperature measurements and have therefore to be avoided.

2.4 Functions

2.4.1 Air Quality Sensor

The air quality sensor measures the VOC concentration and converts it into the CO_2 equivalence. This signal is only used internally and is not output.

2.4.2 Humidity Sensor

The integrated humidity sensor measures the current humidity in the room in order to reduce the humidity by opening the window in case of too high humidity. This signal is only used internally and is not output.

2.4.3 Function Temperature Limitation

The fixed temperature of 16°C prevents the room from being cooled down too extensively. If the indoor temperature falls below this value, the window(s) is/are closed.

2.4.4 Function Window Control

The automatic operation of the window control is only active, if the function switch at the control panel is in AUTO position. In this mode the LED is lit in green.

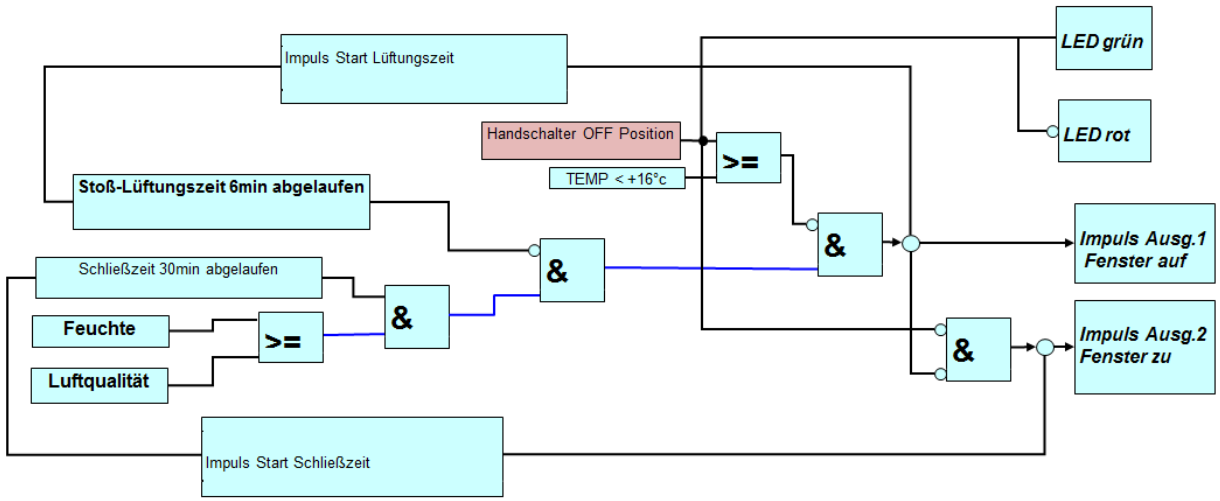
In OFF position the LED is red. (The functionality of the device is turned off.)

If either the thresholds of the air quality or those of the humidity are exceeded, the controller opens the associated windows.

At good air quality and/or low indoor humidity, the windows stay closed in switch position AUTO.
At poor air quality and/or exceeded indoor humidity, the windows are opened.

During the opening/closing of the automatic windows, there is no possibility to change the direction. When the final position is reached, the inversion of the direction is performed with delay.

For energy-optimized ventilation the window is only opened for max. 6 minutes, and the automatic windows then stay closed for at least 30 minutes. The sequence is repeated if the thresholds set by the adjusting wheel are still or again exceeded.



Function block diagram

The control parameters are factory-set, an adaptation to the application, however, is possible via MODBus.

3 Installation

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

- Do not mount the transmitter next to doors, windows, air inlets and outlets.
- Free air supply must be granted.
- Vertical mounting (air inlet at the transmitter down/up)
- Avoid direct sunlight.
- No heat sources around in case of temperature measurement.

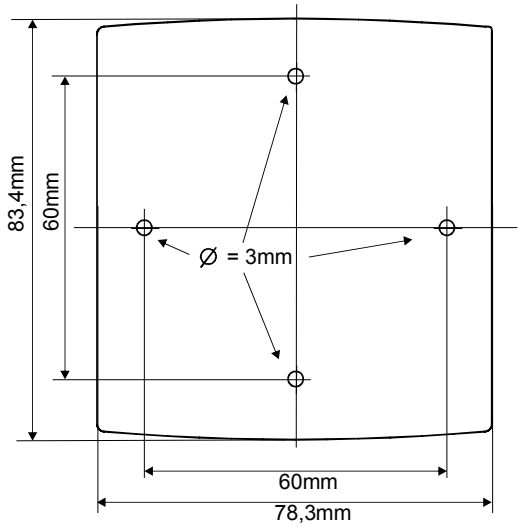


Fig. 3: Mounting VOC Transmitter

4 Electrical Connection

- The connection is done via screw-type terminals with a section of 0.25 to 1.5 mm^2.
- The connection of the different applications is shown in the figures 7 to 11.
- For ModBus wiring we recommend using the cable Y(St)Y 2x2x0.8 LG, in line topology and without any branch lines. Please consider in addition all regulations concerning the wiring of RS-485 field bus wiring.

5 Commissioning

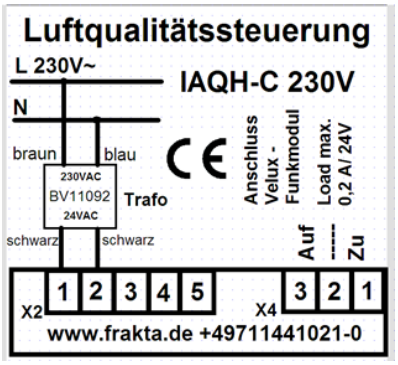
- Check for correct mounting location.
- Check power voltage at the terminals 1 (+) and 2 (GND) at X2.
- Check the output terminals to the VELUX radio switch terminals X4 1,2,3
- Check power supply
- Rack in of the power supply
- Switch on position AUTO→ LED is lit in green
- Turning the knob to the right (line upwards) → For opening the window
- Turning the knob to the left (line downwards) → For closing the window

6 Troubleshooting

- If the LED at the device is flashing in turn red and green – there is an internal error and the device is out of order. Please call your contact person.

7 Figures

Version 230 V power supply



Version 24V power supply

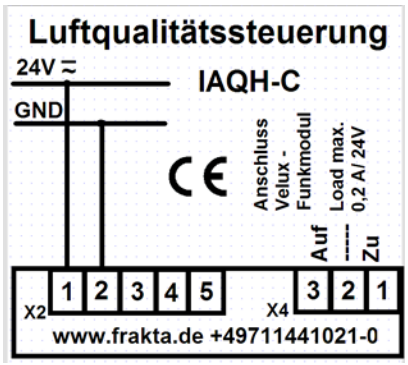
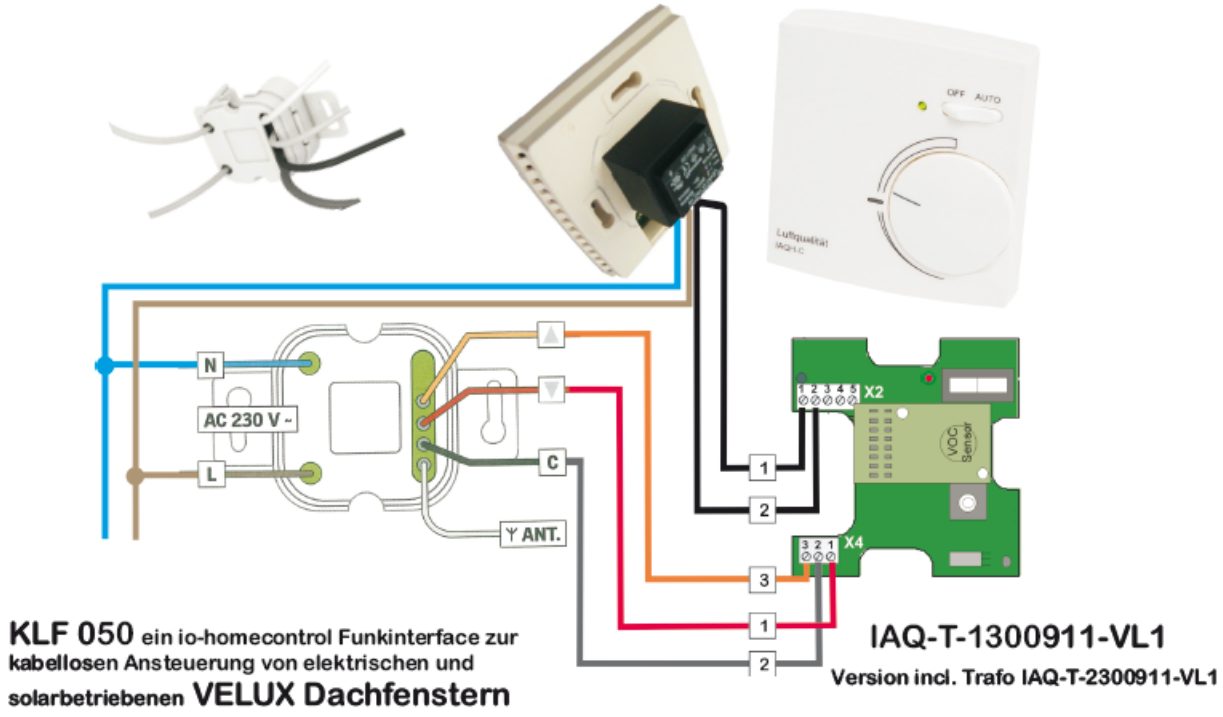


Fig. 10: Electrical connection 230V version



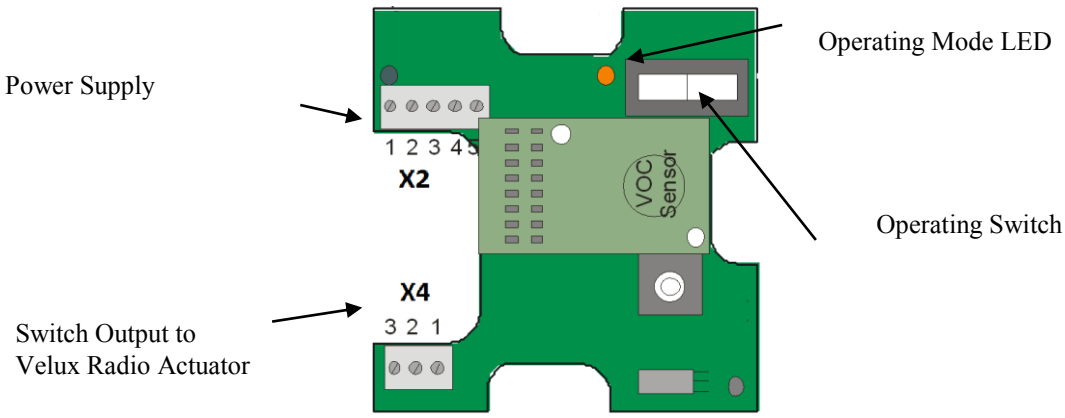


Fig. 12: Terminal positions of the PCB

8 Specifications

Electrical	
Supply voltage 24 V version 230 V version	24 VAC ±10%, 50 Hz /VDC±20% 230 VAC ±20%, 50 Hz
Power consumption	Approx. 30 mA + power of the digital outputs
VOC sensor data	
Gas type	VOC (alcohols, aldehydes, aliphatic hydrocarbons, amines, aromatic hydrocarbons, carbon monoxides, methane, LPG, ketones and organic acids)
Sensor element	Metal oxide semi-conductor
Measuring range	450 – 2,000 ppm CO_2 equivalency
Accuracy	± 150 ppm
Repeatability	± 5 % of reading
Response time	$t_{90} \leq$ 60 s
Warm-up time	20 min
Expected life time	> 10 years/ normal ambient conditions
Temperature sensor data	
Sensor element	NTC
Measuring range	0 – 50 °C (32 to 122 °F)
Accuracy	1 % of reading
Humidity- sensor data	
Sensor element	SMD Polymer
Measuring range	0 – 100% RH
Accuracy	± 3 % of reading
Expected life time	> 10 years/ normal ambient conditions
Output signal	
Digital output signals	Option: max. 60V AC / DC 20 mA
Ambient conditions	
Humidity	15 – 90 % RH non condensing
Temperature	0 °C to + 50 °C (32 to 122 °F)
Temperature storage	5 °C to + 50 °C (41 to 122 °F)
Pressure range	Atmosphere ± 10 %
Physical	
Housing	Plastic ABS
Colour	Pure white similar to RAL 9010
Weight	Approx. 95g (0.21 lb.)
Wire connection	Screw-type terminal min. 0.25, max. 1.5 mm^2
Directives	EMC Directives 2004/108/EEC EN 61000-6-2, EN 61000-6-3 72/23/EEC: EN 60730
Electrical	
Elektrisch	
Versorgungsspannung	24 VAC/VDC±20%, 50 Hz
Leistungsaufnahme	ca. 30 mA zuzüglich Leistung der digitalen Ausgänge
VOC- Sensordaten	
Gasart	* VOC (Alkohole, Aldehyde, aliphatische Kohlenwasserstoffe, Amine, aromatische Kohlenwasserstoffe, Kohlenmonoxide, Methan, LPG, Ketone und organische Säuren)
Sensorelement	Metall Oxid Halbleiter

9 ModBus

9.1 General

The ModBus protocol was developed for the data exchange between information processing units, programmable logic controllers and other intelligent systems. A master computer communicates with maximum 247 connected devices via a serial data link of RS-485 standard. There is only one device (host, master) per bus line determining the telegramming. The other devices (clients, slaves) only react on the request of the master and are never allowed to send data on the bus line without request of the master device.

The data are transmitted in form of data telegrams. There are two possible formats within the ModBus protocol, the ASCII and the RTU format. Only the RTU format is used and described in here.

The RTU telegram settings don't include any tag delimiters.
The beginning and the end of data telegrams are realized by short stops.

The syntax is as follows:

Address	Command	Data	CRC16

The data are transmitted with binary code. The address and the command are 1 byte each. When requested from the master, the data may contain for example address, order and the initial address and the number of data to be retrieved.
The answer from the slave is structured in the same way. The data may contain, besides the address and the order, for example the number of sent data bytes and the data.

CRC16 is a 2-bytes Cyclical Redundancy Check.

The end of the data telegram is recognized if there is an idle period of minimum 2 characters.

The slaves react to valid requests after a certain timeout after receipt of the last character by giving the corresponding answer. The master then expects the start of the answer. If it doesn't come, the master can occupy the bus anew and give new commands. The slave answers after a silence of 3.5 characters at the earliest. In case of transmission errors or not executable commands, the slave doesn't answer or responds with an error message (see troubleshooting).

9.2 Physical Port

The communication between master and slaves uses a serial data link of RS-485 standard.

The port settings are as follows:

9600 Baud, 1 Start Bit, 8 Data Bits, Parity none, 1 Stop Bit

9.3 Time Response

Transmission telegram:

The master can start a data exchange. The master sends a data telegram to a slave containing:

- Address of the slave
- Function requested from the slave (order)
- Data field (variable depending on the order)
- Control characters

The slave starts uploading a telegram after each idle period of 3.5 characters. If the first character is the slave's own address or the address 0 (all), it processes with the telegram. If there is a silence of 2 characters at least, it considers the telegram finished and checks the CRC.

If the telegram is without errors, it executes the function and composes an answer.

Answer telegram:

- Address of the slaves
- Executed function (order)
- Data field (e.g. data length and data)
- Control characters

The answer is sent at the earliest after a silence of 3.5 characters after the end of the master's telegram.

In case of an error, the slave waits for the end of the telegram and the period of 3.5 characters, and then returns an error message.

The master awaits the answer of the slave or a timeout (see table) before starting a new exchange in order to avoid complications resulting from mutual transmissions.

Data organization

The devices offer properties and states generally described here as objects. These objects can be asked specifically as bit or byte ranges by the master and changed by it.

An input object can only be read.

An output object can be read or written.

ModBus functions

The following functions are available with the communication protocol ModBus:

- The main functions granting the data exchange.
- The additional functions for the control and the diagnosis of the data exchange.

The table below indicates the functions managed here.

The functions "Read" and "Write" refer respectively to the action of the master.

Function	Description	Implemented
03	Reading of N output registers	Yes (max 32 reg.)
16	Writing of N output registers	Yes (max 22 reg.)

9.4 ModBus Functional Description

Function 03: Reading of N output registers

This function enables to read the output registers; these are the registers the master can read or write in the slave.

This function enables to read the input registers; these are the registers the master only can read.

Example:

Reading of N registers; function 3

Request:

Slave address 1 - 254	Function 03	Start address	Number of words	CRC16
1 Byte	1 Byte	2 Bytes	2 Bytes	2 Bytes

Answer:

Slave address 1 – 254	Function 03 or 04	Number of sent bytes	Data	CRC16
1 Byte	1 Byte	1 Byte	n Bytes	2 Bytes

9.5 Troubleshooting

If there is any parity, framing, overrun or CRC error during receipt of a telegram, the slave doesn't accept and answer it.

If the slave cannot execute the requested order, it sends an error message.

Format of an error message:

Slave address 1 - 254	Answer code	Error code	CRC16
1 Byte	1 Byte	1 Byte	2 Bytes

Answer code: Order function code + 0x80 (the most significant bit is set to 1).

9.6 ModBus Read Register Description

Read register Request with command 0x03					
Register	**Description**	**Range**	**Default**		
0	Sensor type	(defined by product type)	19505		
1	Measured value: Air quality	0- max (defined in register 11) in ppm			
2	Measured value: Temperature	0- max (defined in register 12) in °C			
3	PID output value VOC	0-10000			
4	PID output value Temp	-10000 to +10000			
5	Measured value: Humidity	0-100% RH			
6	Hysteresis for humidity	Fixed: 10% of the set threshold			
7	Threshold for air quality	Potentiometer value current setting in ppm			
8	Threshold for humidity	Potentiom. value current setting in % RH			
9	Internal				
10	Own MODBus address	1-255	245		
11	Measuring range air quality	0-32767	4000		
12	Measuring range temp.	0-32767 (50 with 1 decimal place)	500		
13-17	Internal				
18	Min. temp. limit cooling protection	0- max (defined in register 12) in °C	16		
19	Ao1 switch	0-6	1		
20	Ao1_Do2 switch	fixed	101		
21	Do1 switch	fixed	101		
22-27	Internal				
28	LED1 switch	0-28	25		
29	LED2 switch	0-28	28		
30	Internal				
31	Initial value air quality	fixed	0		
32	Initial value temperature	fixed	0		
33	Switch potentiometer function	fixed	1		
34	Initial value for analog output 1	fixed	0		
35	Final value for analog output 1	fixed	4000		
36	Output initial value for analog output 1	fixed	0		
37	Output final value for analog output 1	fixed	4000		
38	Initial value for analog output 2	fixed – not used	0		
39	Final value for analog output 2	fixed – not used	500		
40	Output initial value for analog output 2	fixed – not used	0		
41	Output final value for analog output 2	fixed – not used	500		
42-44	internal				
45	Min. potentiom. value air quality	0- max (defined in Register 11) in ppm	900		
46	Max. potentiom. value air quality	0- max (defined in Register 11) in ppm	1600		
47	Min. potentiom. value humidity	0- 100 in % RH	55		
48	Max. potentiom. value humidity	0- 100 in % RH	75		
49	Ventilation time- complete opening	0-32767 in minutes	6		
50	Closed window time after complete opening	0-32767 in minutes	30		
51	Internal				

9.7 ModBus Write Register Description

Write register Command with command 0x10 (16d)					
Register	**Function**	**Possible Range**	**Default**	**Note**	
0	Own MODBus address	1-255	254		
1	Measuring range air quality	0-32767	4000		
2	Measuring range Temp.	0-32767 (50 with 1 decimal place)	500		
3-7	Internal				
8	Min. temperature limit	0- max (defined in register 12) in °C	16		
9	Ao1 switch	0-6	1		
10	Ao1_Do2 switch	fixed	101		
11	Do1 switch	fixed	101		
12-17	Internal				
18	LED1 switch	0-28	25		
19	LED2 switch	0-28	28		
20	Internal				
21	Initial value air quality	fixed	0		
22	Initial value temperature	fixed	0		
23	Switch potentiometer function	fixed	1		
24	Initial value for analog output 1	fixed	0		
25	Final value for analog output 1	fixed	4000		
26	Output initial value for analog output 1	fixed	0		
27	Output final value for analog output 1	fixed	4000		
28	Initial value for analog output 2	fixed – not used	0		
29	Final value for analog output 2	fixed – not used	500		
30	Output initial value for analog output 2	fixed – not used	0		
31	Output final value for analog output 2	fixed – not used	500		
32-34	Internal				
35	Min. potentiom. value air quality	0- max (defined in register 11) in ppm	900		
36	Max. potentiom. value air quality	0- max (defined in register 11) in ppm	1600		
37	Min. potentiom. value humidity	0- 100 in % RH.	55		
38	Max. potentiom. value humidity	0- 100 in % RH	75		
39	Ventilation time- complete opening	0-32767 in minutes	6		
40	Closed window time after complete opening	0-32767 in minutes	30		
41	Internal				

10 Notes and General Information

It is important to read this user manual thoroughly and clearly in order to understand the information and instructions. The IAQ transmitter must be used within product specification capabilities. The appropriate operating and maintenance instructions and recommendations must be followed.
Due to on-going product development, the manufacturer reserves 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.

10.1 Installers' Responsibilities

It is the installer's responsibility to ensure that the IAQ transmitter is 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.

Attention:

- The electrical connections of the device have to be made according to the legal requirements.
- To avoid personal injuries and/or equipment or other property damages, please take care to always disconnect power supply before working on the electrical wiring.
- For avoiding property damages, the device must only be employed within the
- intended use.

Attention:

The circuits used in the device react to electrostatic discharge.
Please take appropriate precautions!

10.2 Maintenance

It is recommended to check the IAQ transmitter 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 IAQ transmitter may be returned for service to the manufacturer.

10.3 Limited Warranty

The manufacturer warrants the IAQ transmitter 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, the manufacturer 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 IAQ transmitter. The manufacturer shall not be liable for any incidental or consequential damages arising out of or related to the use of the IAQ transmitters.

11 Part Disposal

Since August 2005 there are EC-wide regulations defined in the EC Directive 2002/96/EC and in national codes concerning the disposal of 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.