SPM-O2-MODULE IIIm

User Manual

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1 General Information

1.1 About this Product Manual

This product manual describes the construction, the operation and the application areas of the **SPM-O2-MODULE IIIm**. In this manual they will be described as **SPM-O2-MODULE IIIm**.
The manufacturer ensures that this product manual has been written in accordance with the functional and technical features of the delivered **SPM-O2-MODULE IIIm**.
This manual is not subject to the update information service. In case of alterations on the **SPM-O2-MODULE IIIm** following from technical progress the user is responsible for a correct classification of the enclosed additional or updated pages.
A trouble-free and functional operation of the **SPM-O2-MODULE IIIm** can only be guaranteed with knowledge of this product manual. Please read it thoroughly before using.
Pages, tables and illustrations are numbered continuously.
The values shown on the display in this manual are examples of the manufacturer. The process-specific results must be determined by the user.
This manual is written in English.

1.2 Safety Symbols

- ***SYMBOL FOR DIRECT IMMINENT HAZARDS***

This symbol is shown with recommendations for industrial safety if a direct danger to the life and health of persons exists.	

If these recommendations are not thoroughly observed, fatal injuries may result.

- ***SYMBOL FOR INDIRECT IMMINENT HAZARDS***

This symbol informs about situations where indirect hazards occur. Degree and intensity of the damage depends on the triggering actions and the behavior of the persons.	

Disregard of these hints may result in damage to or destruction of the entire product or single components, other property, as well as minor injuries.

- ***SYMBOL FOR PROPER USAGE***

This symbol can be found where the observance of instructions, regulations, and proper order of actions/events is important.	

If these notes aren't taken into account, it can come to the damaging or destruction of the product or single components.

1.3 WARRANTY

The manufacturer gives a guarantee for the

- **Product till 12 months after delivery.**

Guarantee and liability claims in the case of personal or instrumental damages are excluded if due to one or several of the following causes:

- **Natural wear and tear.**
- **None utilization of the product according to order.**
- **disdain of the determinations of this equipment manual.**
- **improper placement, putting into operation, operation and maintenance of product.**
- **using the product with ineffective protective measures.**
- **unauthorized functional and technical alterations of the product.**
- **Removal of parts respectively the installation of spare parts or attachments which were not supplied by the manufacturer or approved by him.**
- **improperly carried out repairs or wrong operations.**
- **influences of third side and superior force.**
- **if type label will be peeled off.**

1.4 COPYRIGHT

2 TECHNICAL INFORMATION

2.1 GENERAL SPECIFICATION

Product Name	SPM-O2-MODULE IIIm
Compound	Oxygen O_2
Measuring range	0-3/0-10/0-25/0-100 Vol.%
Heated measuring cell	55°C
Operating temperature	5°C -45°C
Warm up time	60min @20°C Environment
Response time T_{90}	≤ 3 s with 150 mL/min flow and gas change from nitrogen to air
Linearity error	<±1 %FS
Stability (zero)	<±0.1 % of O_2 per week. First operation after transport can be higher
Stability (span)	<±1% of O_2
Repeatability	<±0,03% of O_2 (time base for gas switch ≥ 5 min)
Temperature drift. (zero)	Type IIIm <±0,02% of O_2 per °C
Flow rate influence	Type IIIm <±0.1% of O_2 between 20 and 800ml/min
Effect of tilt	<±0.02% of O_2 per 1° tilt from horizontal
Analog output	(0)4..20 mA isolated 3000VDC Permissible load resistance 250Ω~350Ω
Digital interface	Option : Modbus 5V TTL
Power Supply	24VDC / 15W
Power /Signal Connector	Weipu SP1310/S7I

2.2 INLET GAS REQUIREMENT

Gas Inlet Flow Rate	Max. 1000 mL/min | Optimal 500mL/min (Flow fluctuations≤±0.02L/min)
Gas pressure	Defined by max flow rate. Optimal <500hPa Outlet pressure less ± 300 hPa. Optimal outlet to free ambient air
Inlet Gas Temp.	5 - 45°C, shall stable
Moisture in Gas	not condensing
Dust in gas flow	100µg/m^3, ≤1µm, Dust filter required
Materials of gas conducting parts	Type III: PU, PVDF, glass, steel 1.4571, gold, viton, platinum/iridium, epoxy resin, nickel Type IIIm: PU, PVDF, glass, steel 1.4571, gold, viton, platinum, epoxy resin, nickel

2.3 CALIBRATION REFERENCE GASES REQUIREMENT

Zero calibration gas	99.999% N_2
Span calibration gas	85 %FS ~100 %FS ***Note:*** For O_2 channel, could use dry and clean air to make span calibration if the measuring range is (0…25)%.

Note：

All reference gas must meet the requirements of inlet gas described in "*2.2 INLET GAS REQUIREMENT*" when flowed into module and make calibration.

2.4 STANDARD TYPES

The standard types of SPM-O2-MODULE IIIm:

	SPM-O2-MODULE IIIm (Oxygen) Range 0..5Vol.% ±1Vol.% in N2 Output 4..20mA 24VDC Tube : Out 6/4 In 4/2.5
	SPM-O2-MODULE IIIm (Oxygen) Range 0..10Vol.% ±1Vol.% in N2 Output 4..20mA 24VDC Tube : Out 6/4 In 4/2.5
	SPM-O2-MODULE IIIm (Oxygen) Range 0..25Vol.% ±1Vol.% in N2 Output 4..20mA 24VDC Tube : Out 6/4 In 4/2.5
	SPM-O2-MODULE IIIm (Oxygen) Range 0..100Vol.% ±1Vol.% in N2 Output 4..20mA 24VDC Tube : Out 6/4 In 4/2.5
	SPM-O2-MODULE IIIm (Oxygen) Range 80..100Vol.% ±1%[FS] in N2 Output 4..20mA 24VDC Tube : Out 6/4 In 4/2.5
	SPM-O2-MODULE IIIm (Oxygen) Range 90..100Vol.% ±1%[FS] in N2 Output 4..20mA 24VDC Tube : Out 6/4 In 4/2.5

Other types on request.

Standard electrical output : 4...20mA
All module also available with ModBus 5VDC TTL interface. This ModBus version has no internal calibration, output numeric ~5000 to 45000. It requires a calibration on application side by user.

Standard gas connection : Tube, Out 6/4 In 4/2.5
Optional gas connection: 1/8" NPT-F.

2.5 OPTIONS AND ACCESSORIES

For SPM-O2-MODULE IIIm:

accessory	Standard Sensor Connection Cable 1.5m Weipu SP1310/S7I
option	1/8" NPT-F Gas Connections with - Analyzer Gas connection 6mm PTFE Tube 1 Set Inlet/Outlet - Analyzer Gas connection 6mm Rubber Tube 1 Set Inlet/Outlet - Analyzer Gas connection 6mm Stainless Steel 1 Set Inlet/Outlet - Analyzer Gas connection 10mm Stainless Steel 1 Set Inlet/Outlet - Analyzer Gas connection 1/4" Stainless Steel Tube 1 Set Inlet/Outlet - Analyzer Gas connection 1/8" Stainless Steel Tube 1 Set Inlet/Outlet
Option	ModBus Digital Output

2.6 ENVIRONMENTAL LIMITS

Operating Temp.	5℃...45℃
Ambient Humidity	Up to 90% rel.Humidity(not condensing)
Others	Use this device • indoors • a vibration-free place • a place which is clean around the device

2.7 STORAGE

Refit any protective cover and place the device and any associated equipment in its original packing before storage. Store them in a clean, dry area.

Storage Temp	-25℃~65℃
Storage Humility	0% RH~90% RH (not condensing)
Dimension	See drawing

2.8 INTERFACE AND PIN ASSIGNMENT

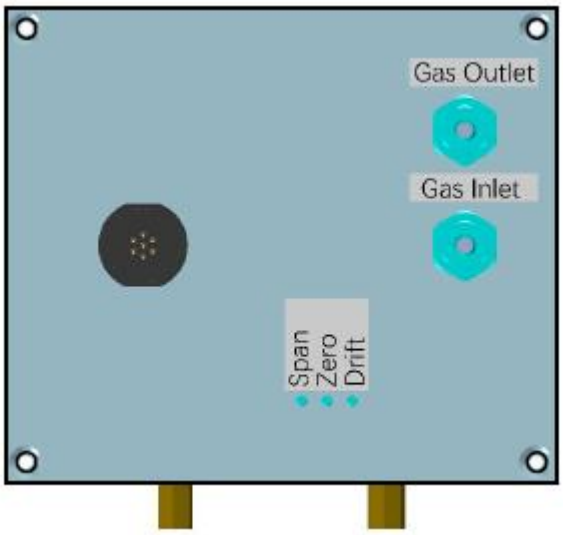

Figure 1 : Front View

Pin	Name	Function
1 white	VCC	Power supply / 24 VDC
2 brown	GND	Ground
3 yellow	VHeat	Heating power 24VDC
4 blue	GNDHeat	Heating power GND
5 gray or black	IOUT+	4...20mA Output +
6 green	IOUT-	4...20mA Output -
7 red	NC	NC

Figure 2 : El. Connection 4..20mA Version(standard)

Pin	Name	Function
1 white	VCC	Power supply / 24 VDC
2 brown	GND	Ground
3 yellow	VHeat	Heating power 24VDC
4 blue	GNDHeat	Heating power GND
5 gray or black	NC	Not Connected
6 green	NC	Not Connected
7 red	ModBus	One wire modbus signal

Figure 3 : El. Connection ModBusVersion(optional)

2.9 MECHANICAL DIMENSION

Dimensions	200/120/103.2mm L/W/H 200/120/113.2mm L/W/H with stands L: 215mm with Gas connections

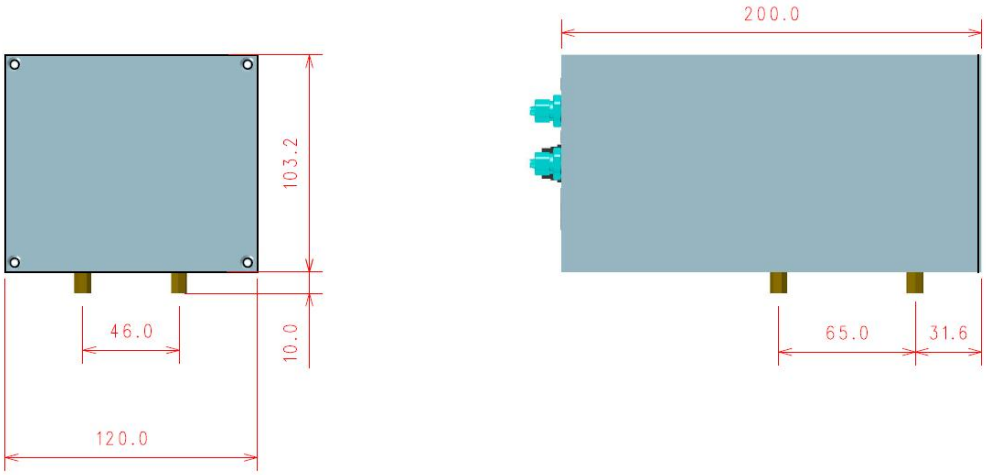

Figure 4 : Mechanical dimension

2.10 MEASURE PRINCIPAL INTRODUCTION

The paramagnetic sensor utilizes the paramagnetic susceptibility of oxygen.

The sensor incorporates two glass spheres mounted on a rotating suspension. This assembly is suspended in a strong magnetic field. The oxygen in the surrounding gas is attracted to the magnetic field, resulting in a force on the lass spheres. The strength of torque acting on the suspension is proportional to the oxygen content of the surrounding gases.

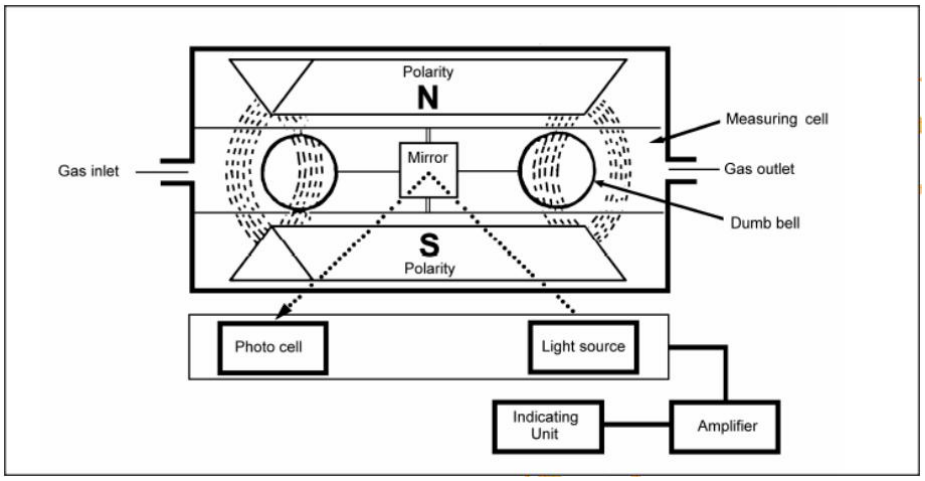

Figure 5 : Para-magnetic sensor principle

Refer to the Figure, the measuring system is "null-balance". Firstly the "zero" position of the suspension assembly, as measured in nitrogen, is sensed by a photo-sensor that receives light reflected from a mirror attached to the suspension assembly. The feedback achieves two objectives.

Firstly, when oxygen is introduced to the cell, the torque acting upon the suspension assembly is balanced by a restoring torque due to the feedback current in the coil. The feedback current is directly proportional to the volume magnetic susceptibility of the sample gas and hence, after calibration, to the partial pressure of oxygen in the sample. Therefore the current gives an accurate measurement of the concentration of oxygen in the gas mixture.

Secondly, the electromagnetic feedback "stiffen" the suspension, damping it heavily and increasing its natural frequency, making the suspension resilient to shock.

As the instrument uses an absolute measurement principle, once built and factory calibrated, it does not require any further factory calibration.

3 INSTALLATION

3.1 SAFETY INFORMATION

The **SPM-O2-MODULE IIIm** has to be installed in a dry and dust-free area.
No heat sources or appliances which produce strong magnetic fields (e.g. electro-motors, transformers) should be put near of installation site.
Penetration of liquids into the **SPM-O2-MODULE IIIm** will lead to serious damages or the complete destruction of the device.
Do not use **SPM-O2-MODULE IIIm** in an area subject to high levels of vibration. Otherwise it will lead to abnormal working, or cause damage.
This device is not explosion-proof type. Do not use it in a place with explosive gases to prevent explosion, fire or other serious accidents. Ensure that the external connections are leak free at full operating pressure.

3.2 UNPACKING

Visually check for any package damage. Open the shipping package and carefully remove the device from the packing materials. Inspect the device for any sign of damage, loose parts. If there is any apparent damage to the inside or outside of the device due to shipping or handling, notify the shipper immediately.

If there are any damage or abnormal, take photos for complainant use.

4 OPERATION

4.1 PREPARATIONS FOR OPERATION

4.1.1 PRECAUTION

Before start to operation：
Double-check if gas tubes and fittings are correctly connected! Double-check for proper wiring!

Depending of orientation, vibration and shock during transport the accuracy of an **SPM-O2-MODULE IIIm** will not reach specification after mounting upright.

Related on strange of shock or duration of none vertical position, this effect can hold up to a week

It is strongly recommended to check and/or redo the calibration after vertical mounting after a week

4.2 ZERO CALIBRATION

- Power on at least one hour to reach stable temperature
- Feed zero Gas (e.g. 99.999% N_2) by constant flow rate for 30min
- Connect a high resolution multimeter to the analog output
- Adjust the zero point to 4mA output by the related potentiometer

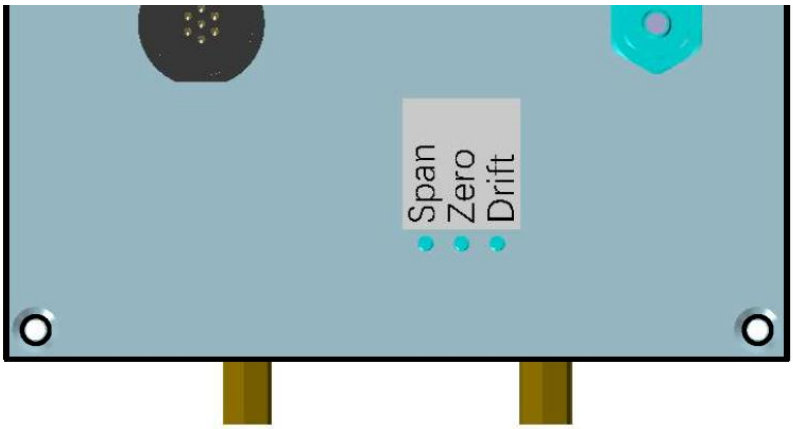

Figure 6 : Zero and span calibration

If the product is Modbus version (option), The digital output value shall be adjusted to numeric 5000 @N_2. Values < 5000 will correspond to negative offset.	HINT

4.3 SPAN CALIBRATION

- After processing the zero calibration
- Flow span reference Gas (e.g. O_2 25Vol.%) by constant flow rate for 30min
- Connect a high resolution multimeter to the analog output
- Adjust the spam point to the correct output current by the related potentiometer
- Calculate the output current by exact given value of reference gas
- Output Current = 4 + (16 x Concentration-of-Reference-Gas / Span-Value-of-Sensor)

If the product is Modbus version (option), The digital output value shall be adjusted to numeric 45000 for span gas.	HINT

4.4 CALIBRATION DRIFT

When the zero and span calibration potentiometer at the end, then zero data is not 4mA, or span data is not 20mA, We can adjust this drift potentiometer to make sure zero data is 4mA, or span data is 20mA.

If the product is modbus version(option), the drift adjustment is same as the analog version.

5 OPTION: MODBUS (TYPE IIIM)

5.1 MODBUS ASCII COMMUNICATION

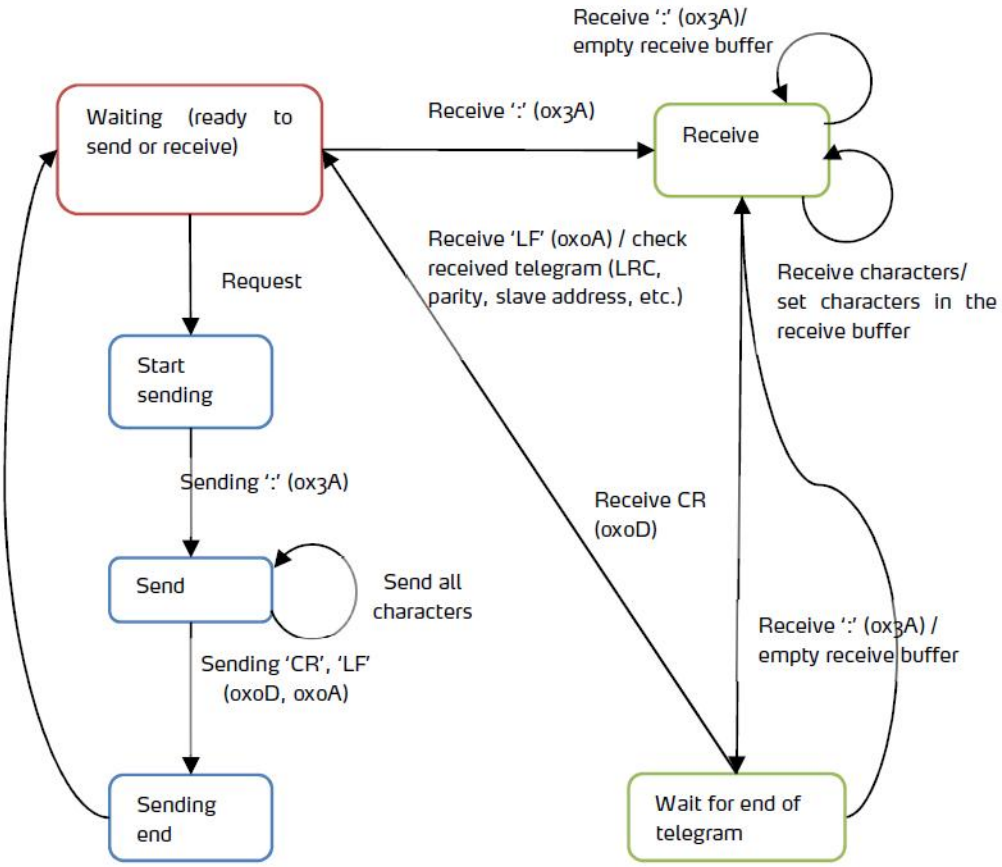

Figure 7 : ModBus ASCII (optional)

5.1.1 DATAGRAM STRUCTURE

The following section describes how a request data string is constructed.
The example below shows the current modulation read off from a **SPM-O2-MODULE IIIm,** with address 160.

Example string looks as follows :A00300050001A6\r\n

Start	Address	Ctrl.Command	Data	LRC Checksum	End \r\n
1 Character	2 Character	2 Character	8 Character	2 Character	CR LF
:	A0	03	00 05 00 01	A6	0D 0A

Addresses, control commands and data are prefixed with “0x” and
the actual address / commands as “nn”.
The “0x” merely indicates that the data is hexadecimal, but since the Modbus Protocol ASCII is defined as hexadecimal, this information is superfluous and
only the address or command is transferred.
The string contains no “0x” and “0x05” becomes “05”.

HINT

Start :

As a rule data strings start with a colon“:”, irrespective of whether they are requests or replies.

Address :

This defines to which device address the string is assigned. As standard, the device address is printed on the serial number label of the product as delivered.

To search for unknown Modbus addresses, the product has to be connected at first. Now any register (e.g. concentration) can be requested from all possible addresses (1-255) with a timeout of one second. A module with the correct address responds by sending a reply. This reply includes the module address so that at the end of the search cycle it is possible to see by processing the reply which module addresses are currently connected to the bus system.

5.1.2 CONTROL COMMAND

The control commands indicate what needs to be done with the aforesaid address.
Basically the product distinguishes between:
Read from register 0x03
Write into register 0x06
The command in the example shown here is “Read Register” (0x03 → 03)

Data

The register number is sent in data as a parameter. In the example here it is:
“Start Address High (0x0005 → 00) / Low (0x0005 → 05)” and
“Number Register High (0x0001 → 00) / Low (0x0001 → 01)”

The Start Address High” and “Start Address Low” indicate to which register address the control command is directed; in this case, address 0005 → 0x0005 “MOD”.
“Number Register High” and “Number Register Low” state how many registers beginning with the start address should be read. Should 10 Registers be read, then 0010 needs to be entered.
In the example registers 05 to 14 would be read out and transferred.

Data is transferred in its hexadecimal form! The number of bytes doubles after conversion to from ASCII to Hex.	HINT

Checksum

The checksum calculates according to a LRC method (Longitudinal Redundancy Check) from all the bytes sent without CR and LF characters.
The bytes are added and the sum subtracted from 0xFF.
0x01 is added to the result, making the LRC complete.
In the example shown above here, the value is "A6"
The checksum is always transmitted with the data and recalculated by the recipient. Should a value in the data set become corrupt, then the checksum calculated by the recipient would be different from that sent. The data set in this case would be unusable.

A reply to the string above would look as follows :A00302000109\r\n

Start	Address	Ctrl.Command	No. of Bytes transferred	Data	LRC Checksum
1 Character	2 Character	2 Character	2 Character	4 Character	2 Character
:	A0	03	02	00 01	09

Example of calculation a Checksum

Table of Values

Hex.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Dec.	48	49	50	51	52	53	54	55	56	57	65	66	67	68	69	70

Example string looks as follows：A00300050001

	Address		Command		Start Register				Register Count				Sum
String Hex.	A	0	0	3	0	0	0	5	0	0	0	1	
	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
Acsii Dez.	65	48	48	51	48	48	48	53	48	48	48	49	602

Sum in ASCII (dez): 602- 256 = 346
346 -256 =90(Rest)
Checksum: 255 – 90 + 1 = 166 (ASCII dez.)
166(ASCII dez) → A6 (String hex.)
The string hast to be enlarged : Data String + Checksum = String to send
A00300050001 + A6 = A00300050001A6

The checksum will be transmitted each time and checked by the receiver.
If the checksum is not correct the product will not accept the command.

5.1.3 SIGNAL TRACE

The figure below shows a potential scenario of a data exchange between the master and the connected subscriber/s (primarily). This assumes a baud rate of 2400 and the Modbus communication running in ASCII mode. Times vary accordingly for other baud rates.

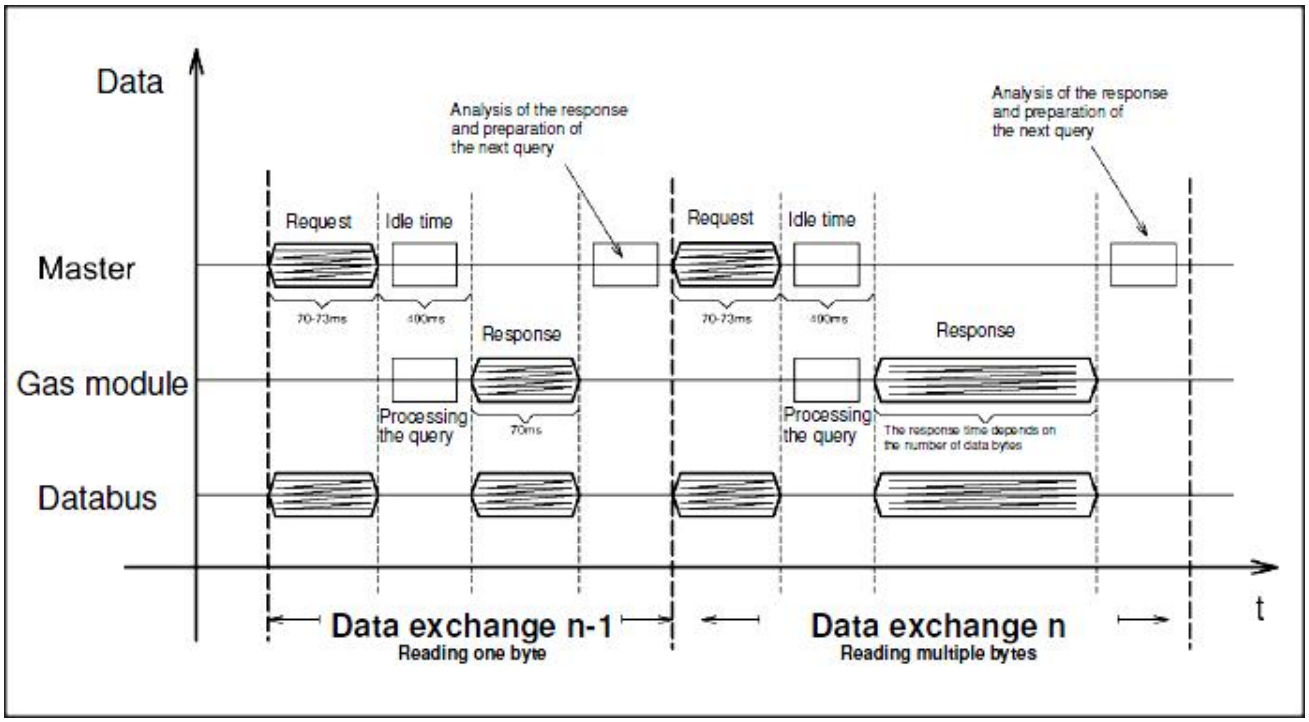

Figure 8 : Modbus signal trace (optional)

The duration of a query string is 70–73 ms. A brief pause (max. 400 ms) may then follow. The module response then follows. This depends on the number of bytes being read out. If only one byte is read out, the module response is approx. 70 ms. When multiple bytes are being read out, the response phase is correspondingly longer. Basically, it can be said that the product reacts to a correct query reliably within 400 ms. The character string is

Serial Protocol Parameter Baud rate :2400 Data bits :7 Stop bits :1 Parity : Even	HINT

then sent immediately without a response pause.

Electrical Parameter of Modbus 5VDC one wire This bus is designed only for usage inside of devices and not galvanic shielded The device itself need to be EMI save	⚠

5.1.4 MODBUS REGISTER LIST

Measured value 0x000A R/O	In this sample mobus address 0x01(Factory Default) is used Command(HEX): 3A 30 31 30 33 30 30 30 41 30 30 30 31 41 41 0D 0A Command(ASCII): :0103000A0001AA\r\n Reply data: :010302XXXXYY\r\n XXXX: measure value YY: checksum The data to concentration: Module 0-25Vol.% Value 5000(0Vol.%) - 45000(25Vol.%) Module 0-100Vol.% Value 5000(0Vol.%) - 45000(100Vol.%) Module 95-100Vol.% Value 5000(95Vol.%) - 45000(100Vol.%) By factory default the module is adjusted to zero offset of 5000 to ensure a negative offset can be calibrated by upper routines
Modbus Adress 0x00C0 R/W	Current Modbus address The addresses can be written and read After address has been changed, following communication with the product is only possible via new address. Normally (default) the Modbus address is printed on serial number label but could be changed by user! **CAUTION : Never set address to zero 0x00.** **Otherwise will cause communication error, this is personal damage, is not in scope of guarantee.** 
Zero Value 0x0059 R/O	Module 0-25Vol.% zero value is 0 Module 0-100Vol.% zero value is 0 Module 95-100Vol.% zero value is 95
Span Value 0x005A R/O	Module 0-25Vol.% span value is 25 Module 0-100Vol.% span value is 100 Module 95-100Vol.% span value is 100
Serial Number 0x0080 - 0x0083 R/O	Serial Number of Device : wwmm-nnnn
Software Version 0x0084 - 0x0085 R/O	Software version : ASCII Vx.xx
Modul Number 0x0086 - 0x0089 R/O	Serial Number of Core : xxxxx

6 MAINTENANCE

6.1 DAILY MAINTENANCE

- Calibration
  If the measure values are abnormal and no fault found after the error check, the calibration should be carried out. For the calibration procedures, refer to“4.2. - 4.5.”.
- Flow rate check
  Check if the flow of inlet gas meet the requirements described in “2.2.”.

7 APPENDIX

7.1 FAQ

7.1.1 HOW TO CLEAN PRODUCT INSIDE

If something like Oil is inside the sensor please contact your local dealer to offer service.
If humidity condensed inside the **SPM-O2-MODULE IIIm**, it mostly can dried by flowing with N2 (dry) for longer (more than 1h). If, after this procedure, the **SPM-O2-MODULE IIIm** will not have stable function, please contact us to offer service.