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DOAS (Differential Optical Absorption Spectroscopy) / NDUV Mudule-H2S Specification

Updated: Jan 2024

1. Principle

DOAS (Differential Optical Absorption Spectroscopy) is a well-established principle for gas concentration measurements. DOAS module is based on the principle of ultraviolet absorption, using optical principles and non-contact measurement. It is based on the principle of ultraviolet and passes inspectionMeasure the unique absorption spectrum of the gas to make accurate quantitative analysis and calculate its concentration value

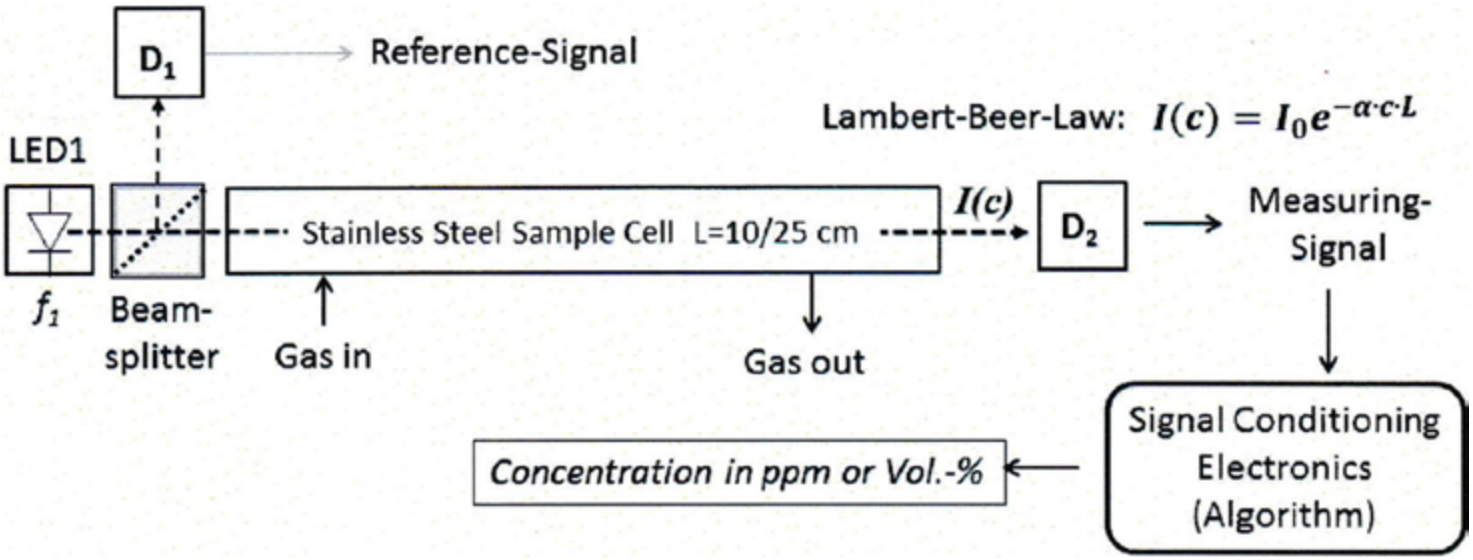


Figure 1. Schematic Diagram

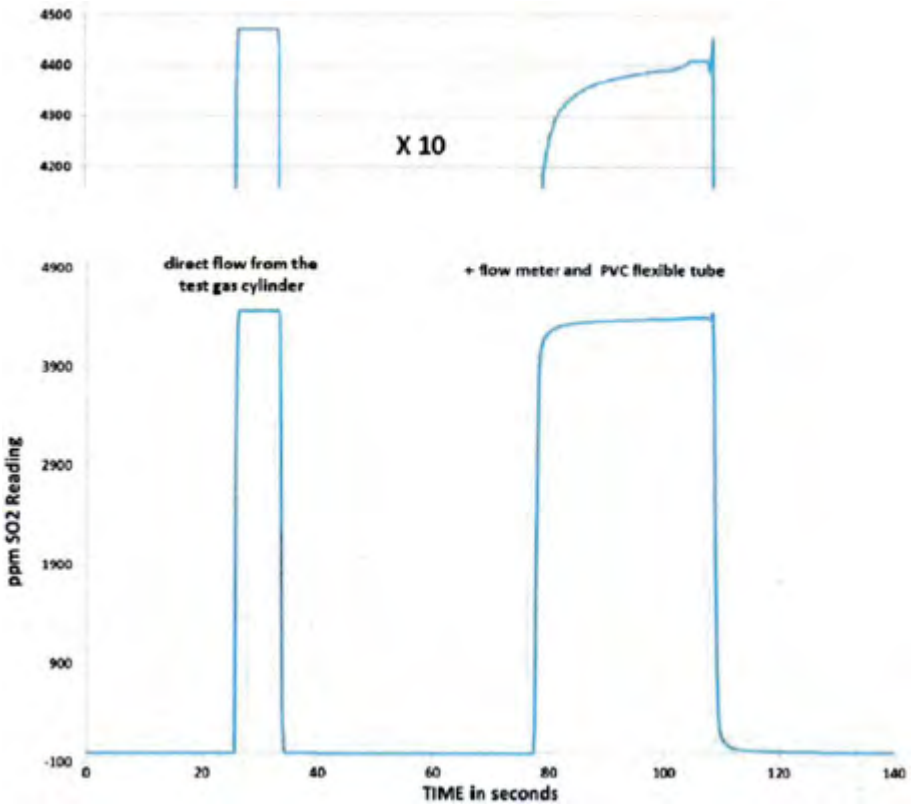
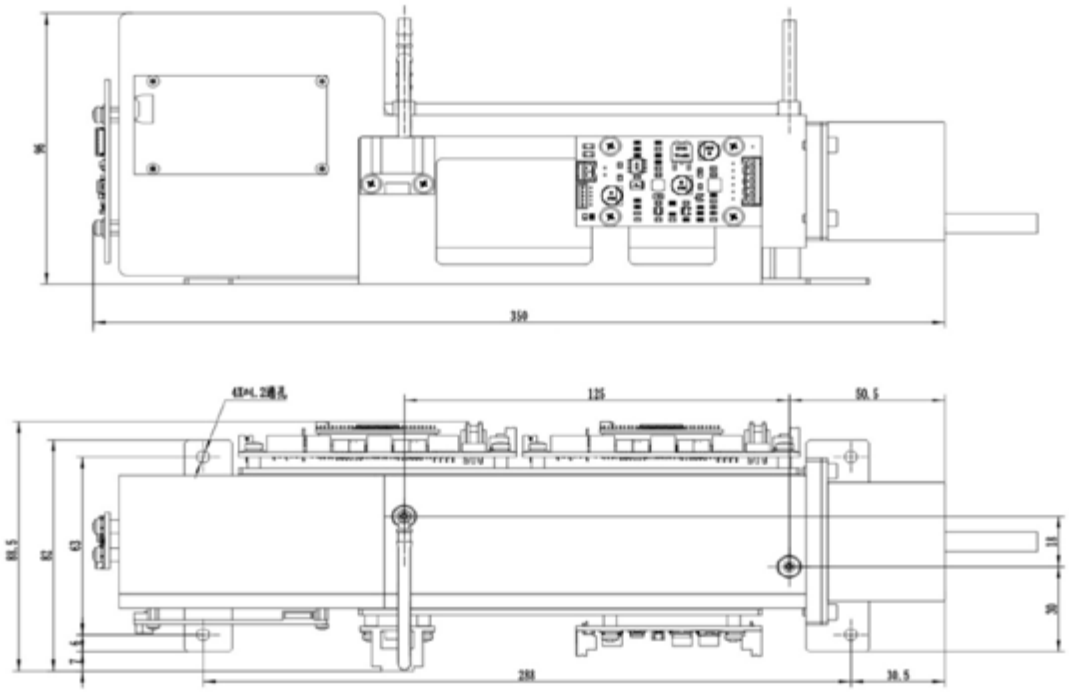


Figure 2. The responses of gas reading under different circumstances

2. Technical Data

Technical indicators (customer customized version)	
Detect gas	H2S
Sampling method	Flow
sensor type	DOAS
Range	0-20ppm
Measurement error	±2%F.S.
Limit of detection	0.1PPM
Response time(T_{90})	≤20s
Output signal	RS232
Ventilation flow rate	1~1.5L/min
Housing material	Sheet Metal
Tracheal interface size	4/6mm
Supply Voltage	12v±1v, Current>500mA
Working current	Normal operation: not greater than 200mA
	Impulse current: not exceeding 300mA
weight	<2kg
size	350mm* 110mm* 110mm (Based on the actual product)



3. Operating instructions

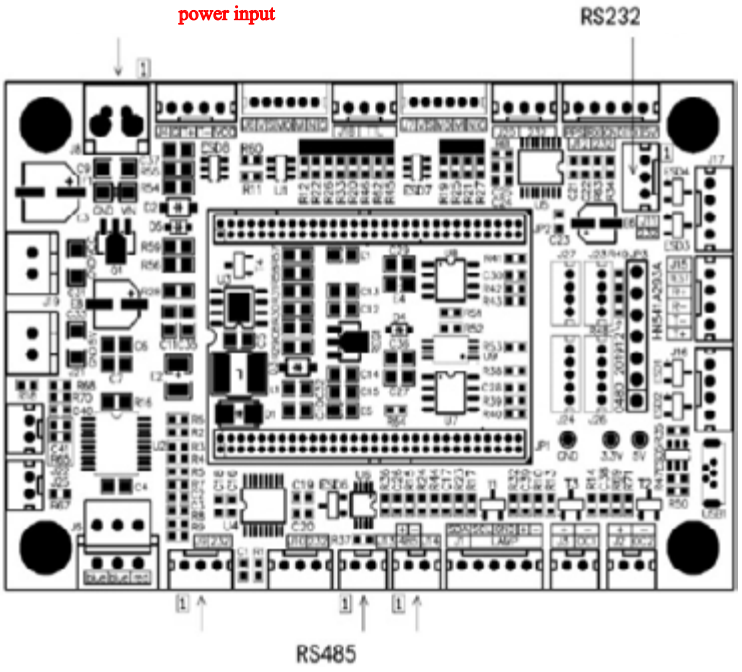
3.1 Operation condition

It needs to be operated in a dry and dust-free condition, and installed in a nearby place where there should be no heat source or strong magnetic field generated by electrical appliances (such as electric motors, transformers). It should be noted that it is necessary to avoid liquid infiltration.

3.2 Installation guidance

It is necessary to ensure that the sensors at the installation location are not affected by high humidity (condensation), extreme temperature fluctuations, mechanical loads (such as vibration), dust, and dirt.
Under no circumstances should the sensor (or its components) come into contact with water or other liquids! If the sensor is installed near the airflow generated by mechanical or natural ventilation, the module must not be located in strong convection!

3.3 Interface definition and indicator light description



Communication configuration port

Use the module according to its mechanical structure and electrical interface, connect the module inlet and outlet, and note that the pressure sensor is usually located at the outlet;

	Power interface pin description	
Circuit board	J8	
Connector interface pins	1	Positive pole
	2	Negative pole (GND)

	RS232 interface pin description	
Circuit board	J11	
Connector interface pins	1	RS232 TX
	2	GND
	3	RS232 RX

	RS485 interface pin description	
Circuit board	J13	
Connector interface pins	1	A/Y (Differential signal - in-phase)
	2	B/Z (Differential Signal - Inverted)

J9 is connected to the power supply line, and the other end is connected to a DC power supply. Red represents the positive pole, and black represents the negative pole ;

3.4 Communication interface

Supports two communication interfaces, RS485 and RS232, and users can choose one communication interface for communication according to their needs. Note: Only one option can be selected for communication. The module adopts a Modbus ASCII or Modbus RTU format communication protocol, with a default Modbus address of 0x2A.

BAUD	Start bit	Data bits	Stop bit	Parity check	Communication mode
115200 bps	1 bit	7 bits	1 bit	even parity check	Modbus ASCII
115200 bps	1 bit	8 bits	1 bit	even parity check	Modbus RTU

3.5 Register list

Register address	Register Description
0x0017 (read-write)	ModBus address, when the default address is changed, can only communicate with the module through the new address
0x0030 (write-only)	During zero point calibration, this register must be set to 0x01
0x0031 (read only)	Flag for whether zero calibration is completed (1 represents zero calibration completed; 0 represents zero calibration not completed)
0x0032—0x0033 (read-write)	SO2 range calibration coefficient high order
0x0034—0x0035 (read-write)	SO2 range calibration coefficient low order
0x0036—0x0037 (read-write)	NO2 range calibration coefficient
0x0038—0x0039 (read-write)	NO range calibration coefficient
0x003A—0x003B (read-write)	High order H2S range calibration coefficient
0x003C—0x003D (read-write)	H2S range calibration coefficient low order
0x004D—0x004E (read only)	Pressure sensor value
0x004F (read only)	Module status, specific meaning can be found in the module status description table
0x0050—0x0051 (read only)	SO2 concentration value (in mg/m3)
0x0052—0x0053 (read only)	NO2 concentration value (in mg/m3)
0x0054—0x0055 (read only)	NO concentration value (in mg/m3)
0x0056—0x0057 (read only)	H2S concentration value (in mg/m3)
0x0060 (read only)	SO2 high range (in mg/m3)
0x0061 (read only)	SO2 low range (in mg/m3)
0x0062 (read only)	NO2 range (in mg/m3)
0x0063 (read only)	NO range (in mg/m3)
0x0064 (read only)	High range H2S (in mg/m3))
0x0065 (read only)	Low range H2S (in mg/m3)
0x007D—0x007E (read only)	Pressure sensor value (backup group, choose one from two when using)
0x007F (read only)	Module status, specific meaning can be found in the module status description table (backup group, choose one or two when using)
0x0080—0x0081 (read only)	SO2 concentration value (in ppm)
0x0082—0x0083 (read only)	NO2 concentration value (in ppm)
0x0084—0x0085 (read only)	NO concentration value (in ppm)
0x0086—0x0087 (read only)	H2S concentration value (in ppm))
0x0090 (read only)	SO2 high range (in ppm)
0x0091 (read only)	SO2 low range (in ppm)
0x0092 (read only)	NO2 range (in ppm)
0x0093 (read only)	NO range (in ppm)
0x0094 (read only)	High range H2S (in ppm)
0x0095 (read only)	Low range H2S (in ppm)

3.6 Module Status

Status register															
High Byte								Low Byte							
bit15							bit8	bit7							bit0
H_7	H_6	H_5	H_4	H_3	H_2	H_1	H_0	L_7	L_6	L_5	L_4	L_3	L_2	L_1	L_0

bit15	H_7	1 Represents EEPROM abnormality; 0 represents EEPROM normal
bit14	H_6	1 Representing the watchdog reset; 0 represents normal reset
bit13	H_5	1 Representative did not receive instructions from the spectrometer on time; 0 represents normal receipt of spectrometer instructions (UV module only has spectrometer)
bit12	H_4	1 represents spectral anomaly; 0 represents normal spectrum
bit11	H_3	1 represents abnormal pressure; 0 represents normal pressure
bit10	H_2	1 The real-time temperature control value is greater than the temperature control set value by more than 10 ℃; 0 represents that the real-time temperature control value is normal
bit9	H_1	1 represents that it has been preheated; 0 represents not preheating properly
bit8	H_0	1 represents abnormal temperature control communication; 0 represents normal temperature control communication
bit7~bit4	L_7~L_4	
bit3	L_3	1 represents the thermistor value exceeding the threshold; 0 represents no abnormalities
bit2	L_2	1 represents a heating element malfunction; 0 represents no fault
bit1	L_1	1 represents the difference between thermistors exceeding the threshold; 0 represents no abnormalities
bit0	L_0	1 represents a thermistor open circuit fault; 0 represents no fault

3.7 Data Type

Variable	Data Type	Unit
Modbus address	byte	None
Range Value	Unsigned short	mg/m3 o r ppm
Gas concentration	float	mg/m3 o r ppm
Chamber pressure	float	Kpa
Range calibration coefficient	float	None

3.8 Communication function code

The following 3 function codes of the Modbus communication protocol can be used to complete communication with the module:

Read from register (one or more)	0x03
Write instructions to a single register	0x06
Write instructions to multiple registers	0x10

3.9 LRC Check Code

When communicating in Modbus ASCII mode, LRC error correction is performed on the data frame, and LRC checksum is calculated on all data bytes (in hexadecimal format) except for the start and end codes. The resulting LRC checksum is placed at the checksum position in the frame format for data frame transmission.

①LRC Example of checksum calculation (using address 0x2A as an example)

Address	Function code	Start register	Number of Registers	LRC Check Code
0x2A	0x03	0x00 0x05	0x00 0x04	0xCA

3.10 CRC Check Code

The RTU mode includes an error check field, which is based on the cyclic redundancy check (CRC) method to perform on all message contents. CRC field verifies the content of the entire message. Regardless of the parity check method used for a single character message, this CRC check should be applied. CRC contains a 16 bit value consisting of two 8-bit bytes. The CRC field is attached to the message as the last field of the message. When performing this type of attachment, first attach the low byte of the field, and then attach the high byte of the field.。**The CRC high byte is the last byte sent in the message.**

When communicating in RTU mode, CRC error verification is performed on all messages. The sending device calculates the CRC value and attaches it to the message. During the message receiving process, the receiving device recalculates the CRC value and compares it with the actual CRC value received in the CRC field. If the two values are not equal, it indicates that the message has an error.

4. Communication example (Taking address 0x80 as an example)

Work must be carried out for at least 30 minutes before calibration. The calibration gas (zero and range points) must be stable. After the module is powered on, send instructions to query the module status until the module temperature is controlled properly (after the bit9 in the status register is 1), and then the module calibration can be carried out.

4.1 Zero Calibration

Inject zero gas (nitrogen) into the module inlet according to the specified flow rate, and after 3 minutes of zero gas supply, send a zero calibration command to the module. After receiving the zero calibration response command from the module, continuously send instructions to check whether the zero calibration is completed. After the zero calibration is completed, the zero calibration operation is completed.

Read the concentration value and send the frame as:

	Start Code	Address	Function code	Start register	Number of Registers	LRC check code	End Code
ASCII	:	0x80	0x03	0x00 0x80	0x00 0x02	0xFB	CR LF
		Address	Function code	Start register	Number of Registers	CRC Check Code	
RTU		0x80	0x03	0x00 0x80	0x00 0x02	0xDBF2	

The response frame is: (concentration result 10.6ppm)

	Start Code	Address	Function code	Byte count	Data Content	LRC check code	End Code
ASCII	:	0x80	0x03	0x04	0x41 0x29 0x99 0x9A	0xDC	CR LF
		Address	Function code	Byte count	Data Content	CRC check code	
RTU		0x80	0x03	0x04	0x41 0x29 0x99 0x9A	0x44F4	

Send the zero correction command frame as follows:

ASCII	Start Code	Address	Function code	Start register	Data Content	LRC check code	End Code
	:	0x80	0x06	0x00 0x30	0x00 0x01	0x49	CR LF
RTU		Address	Function code	Byte count	Data Content	CRC check code	
		0x80	0x06	0x00 0x30	0x00 0x01	0x5614	

The response frame is:

ASCII	Start Code	Address	Function code	Start register	Data Content	LRC check code	End Code
	:	0x80	0x06	0x00 0x30	0x00 0x01	0x49	CR LF
RTU		Address	Function code	Byte count	Data Content	CRC check code	
		0x80	0x06	0x00 0x30	0x00 0x01	0x5614	

The command frame for querying whether zero point calibration has been completed is as follows:

ASCII	Start Code	Address	Function code	Start register	Number of Registers	LRC check code	End Code
	:	0x80	0x03	0x00 0x31	0x00 0x01	0x4B	CR LF
RTU		Address	Function code	Byte count	Data Content	CRC check code	
		0x80	0x03	0x00 0x31	0x00 0x01	0xCBD4	

The response frame is: (Zero calibration completed)

ASCII	Start Code	Address	Function code	Start register	Number of Registers	LRC check code	End Code
	:	0x80	0x03	0x02	0x00 0x01	0x7A	CR LF
RTU		Address	Function code	Byte count	Data Content	CRC check code	
		0x80	0x03	0x02	0x00 0x01	0x459A	

4.2 Range Calibration

Before range calibration, zero point calibration needs to be performed first. Please use standard gases within the range of 80% -100% of full range for range calibration. Using standard gases with concentrations exceeding the above range for range calibration may affect the accuracy of subsequent module testing. The range calibration process is as follows:

(1) Send instructions to read the range calibration coefficient of the gas, and record this coefficient as Span_ Old;

(2) Inject a known concentration of Con_ New standard gas;

(3) After the gas concentration reading measured by the module stabilizes, record the measured gas concentration value as Con_ Old;

(4) Calculate the coefficient Span after gas range calibration_ New= Con_ New * Span_ Old/Con_ Old;

(5) Send instructions to write the coefficient Span after gas range calibration_ New;

Read the range calibration coefficient and send the frame as:

ASCII	Start Code	Address	Function code	Start register	Number of Registers	LRC check code	End Code
	:	0x80	0x03	0x00 0x32	0x00 0x02	0x49	CR LF
RTU		Address	Function code	Start register	Number of Registers	CRC check code	
		0x80	0x03	0x00 0x32	0x00 0x02	0x7BD5	

The response frame is: (Range calibration coefficient is 1.0, i.e. Span-Old=1.0)

ASCII	Start Code	Address	Function code	Byte count	Data Content	LRC check code	End Code
	:	0x80	0x03	0x04	0x3F 0x80 0x00 0x00	0xBA	CR LF
RTU		Address	Function code	Byte count	Data Content	CRC check code	
		0x80	0x03	0x04	0x3F 0x80 0x00 0x00	0x66C7	

If the standard gas concentration is 98.0ppm (i.e. Con New=98.0), read the concentration value and send the frame as:

ASCII	Start Code	Address	Function code	Start register	Number of Registers	LRC check code	End Code
	:	0x80	0x03	0x00 0x80	0x00 0x02	0xFB	CR LF
RTU		Address	Function code	Start register	Number of Registers	CRC check code	
		0x80	0x03	0x00 0x80	0x00 0x02	0xDBF2	

The response frame is: (concentration result 100.0 ppm, i.e. Con-Old=100.0)

ASCII	Start Code	Address	Function code	Byte count	Data Content	LRC check code	End Code
	:	0x80	0x03	0x04	0x42 0xC8 0x00 0x00	0x6F	CR LF
RTU		Address	Function code	Byte count	Data Content	CRC check code	
		0x80	0x03	0x04	0x42 0xC8 0x00 0x00	0xFEBD	

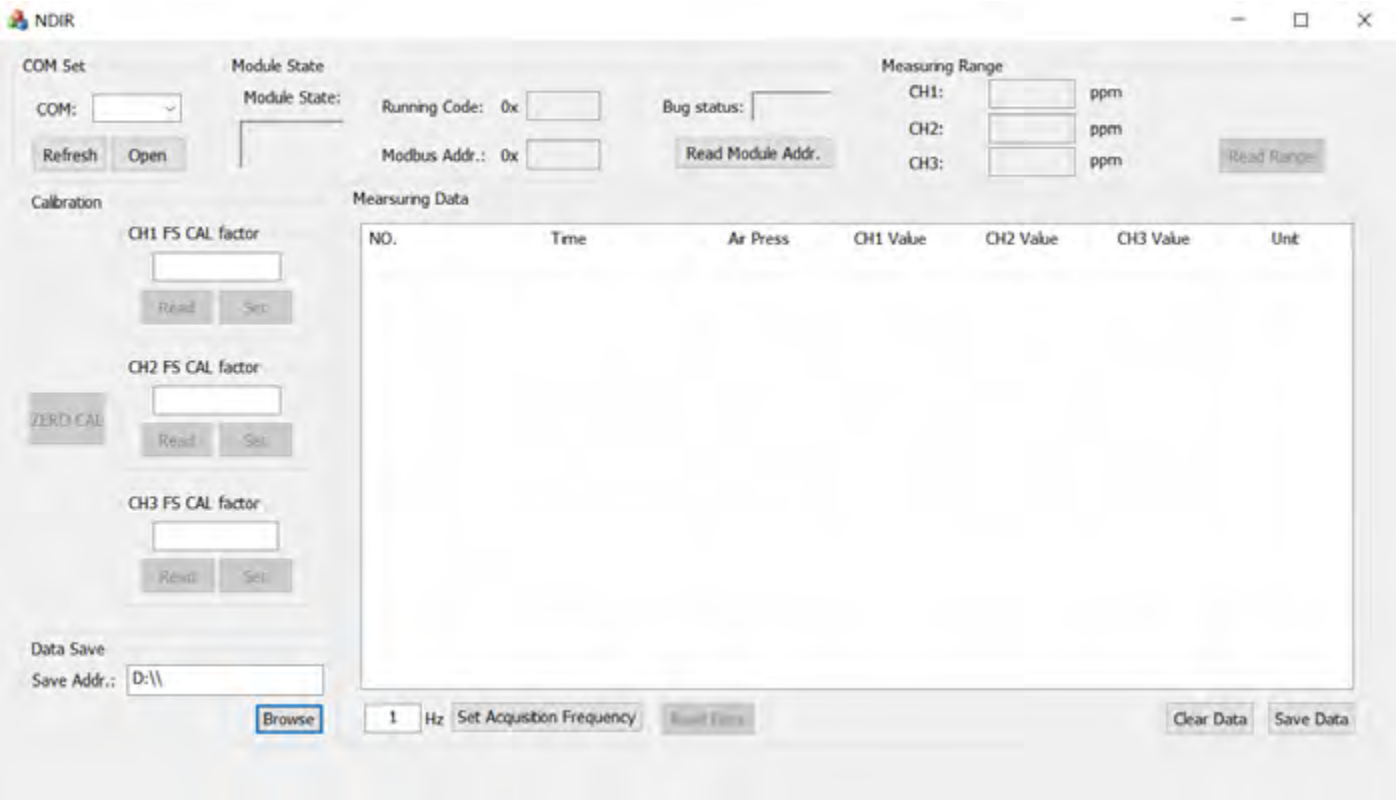
The instruction frame for writing the range calibration coefficient is as follows: (Write range calibration coefficient Span-New =98.0 * 1.0/100.0=0.98)

ASCII	Start Code	Address	Function code	Start register	Number of Registers	Byte count	Data Content	LRC check code	End Code
	:	0x80	0x10	0x00 0x32	0x00 0x02	0x04	0x3F 0x7A 0xE1 0x48	0x56	CR LF
RTU		Address	Function code	Start register	Number of Registers	Byte count	Data Content	CRC check code	
		0x80	0x10	0x00 0x32	0x00 0x02	0x04	0x3F 0x7A 0xE1 0x48	0xB9F7	

The response frame is:

ASCII	Start Code	Address	Function code	Start register	Number of Registers	LRC check code	End Code
	:	0x80	0x10	0x00 0x32	0x00 0x02	0x3C	CR LF
RTU		Address	Function code	Start register	Number of Registers	CRC check code	
		0x80	0x10	0x00 0x32	0x00 0x02	0xFE16	

5. Software operation interface



6. Security protection and precautions

① Before using the module, it should be confirmed that the external power supply is 12V DC and reliably connected.

② In case of unexpected events during use, power should be cut off first.

③ After using the module, it should be cleaned with clean air for at least 20 minutes to prevent residual gases from corroding the chamber.

④ When the module is idle for a long time, it should be powered on once a month for no less than 4 hours.

7. Simple faults and troubleshooting methods

Fault phenomenon	Possible reasons	Troubleshooting
After connecting 12V DC power, the module does not respond	12V power supply is abnormal, or there is a problem with the power cord circuit	Measure the 12V voltage output to ensure normal voltage; Measure whether the power cord is reliably connected.
Response time for introducing standard gas>3 minutes	1) Air path leakage 2) Insufficient pressure in the standard gas cylinder	1) Check and confirm that there is no air leakage in the air circuit. 2) Replace the standard gas
Serial port produces garbled code	Baud rate selection error	Baud rate selection 115200