H2SENSE
Leader in hydrogen sensor technology

MODEL5000 Series Hydrogen Transmitter

User Manual

Hydrogen Sense Limited

Contents

1. Product Overview

1.1 Brief Introduction

H2SENSE™ Model5000 Hydrogen Transmitter (for Purity Analysis) is an instrument featuring easy operation, flexible interfaces, and true online hydrogen detection with a measurement range of 0.5% - 100%vol. Using solid-state Pd alloy thin-film technology, the transmitter offers absolute specificity, remaining unaffected by CO, CH and other combustible gases. It can even operate in acidic environments containing H2S, wet Cl2 etc., making it ideal for industrial settings such as hydrogen production, petrochemical, pharmaceutical and semiconductor industries.

Figure 1.1 MODEL5000 Hydrogen Transmitter (for Purity Analysis)

1.2 Model and Specification

ModeL5000 Series					
Model	Measurement Range	Co Limit	H2S Limit	Response Time	Background Gases
5000	0.5%~100%vol	0	0	30s	N2
5020	0.4%~5%vol	0	0	60s	N2 or Air
5030	0.5%~100%vol	100ppm	1000ppm	60s	N2
5040	0.5%~100%vol	20%vol	10%vol	90s	N2

2. Performance & Characteristics

2.1 Sensor

- Based on our independent intellectual property rights of H2Sense™ solid-state Pd alloy thin-film technology
- Specific coating technology ensures that the sensor operates reliably in harsh environments containing CO, H2S, CH etc.
- Optimized alloy doping and thin-film preparation processes ensure excellent long-term stability and eliminate the need for calibration.

2.2 External Structure

The housing is made of aluminum alloy, and the probe rod is made of 316L. It features high mechanical strength, adopts a full sealed structure, and has an IP67 protection rating.

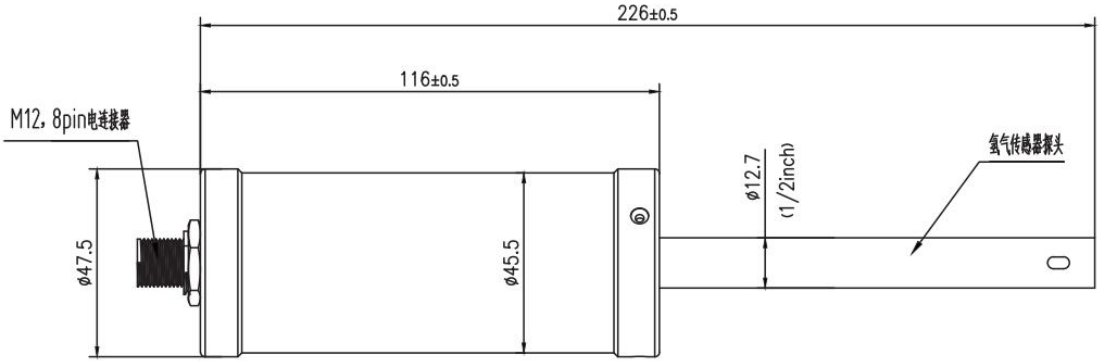


Figure 2.1 Outline Dimension

2.3 Adaptability

The MODEL 5000 Hydrogen Transmitter (for purity analysis) meets the general technical requirements specified in relevant standards and technical specifications of the gas analysis industry, including those for basic functions, communication functions, insulation performance, electromagnetic compatibility (EMC) performance, environmental adaptability, mechanical performance, enclosure protection performance, continuous power-on performance, reliability, service life, as well as appearance and structure.

3. Parameter Characteristics

3.1 Main Performance Indicators

Table 1 Main Performance Indicators of MODEL5000 Hydrogen Transmitter (for purity analysis)

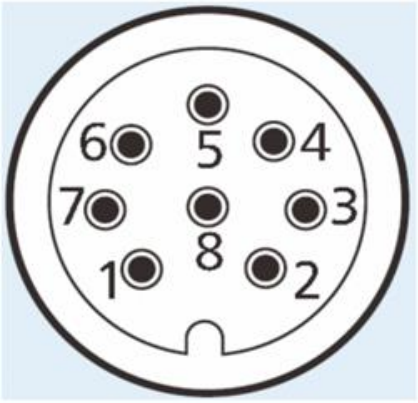
Main Indicators	Measurement Range(H_2)	0~ 99.9%vol H_2/N_2	
	Measurement Accuracy(H_2)	±3000ppm（0~10%vol）	
		±10000ppm（10~99.9%vol）	
	Repeatability(H_2)	±2000ppm（0~10%vol）	
		±4000ppm（10~99.9%vol）	
	Response Time(H_2)	< 60s	

	Gaseous Medium	-40℃ ~ 60℃	Max.100℃*
Gas Selectivity*	**CO***	5%vol	Up to a maximum of 20%vol
	H_2S*	100ppm	Up to a maximum of 3%vol
	Cl_2*	/	
Working Environment	Operating Temperature	-40℃ ~ 55℃	
	Storage Temperature	-40℃ ~ 85℃	
	Working Humidity	0 ~ 95%RH	
Communication & Output	Analogue Output	4 ~ 20 mA	
	Serial Interface	RS232(Configuration and diagnosis) 、RS485	
	Communication Protocol	Modbus_RTU	
Power Supply	Supply Voltage	24V DC（±10%）	
	Electric Current	0.3A（max）	
	Power Consumption	≤2.5W	
Physical Specification	Ingress Protection Rating	IP67	
	Weight	300g	
	Mechanical Interface*	1/2in. MNPT	Can be customized
	Gas Pressure	0~10MPa	Pressure compensation is required when pressure changes dynamically to a large extent.
Others	Certification/Standard	Non	
	Service Life	>10 yrs.	
	Data Storage	Data storage interval：30s，number of stored data items： 109945	

3.2 Power Supply and PIN Definition of Communication Cable

All electrical connections of the transmitter are realized through one 8-core M12

connector. The definitions of the connector pins and matching cable cores are as below. When mating the matching cable plug with the transmitter socket, it is crucial to ensure that the notch positions are aligned, otherwise, the connector pins may be damaged.



Connector Pin No.	Pin Function	Color of the matching cable core
1	24V power supply positive	Yellow/White
2	/	Green
3	/	Green/White
4	232T/D-	Brown/White
5	232RXD+	Brown
6	RS485A	Blue/White
7	RS485B	Blue
8	24V power supply negative	Yellow

3.3 Optional Accessories (Non-standard)

Figure 3.1 shows the wiring of the optional power adapter, terminal board and an RS232/RS485 to USB adapter mounted on a DIN rail. It should be noted that the prices of optional accessories can be obtained from sales personnel. Product failures caused by incorrect selection or functional defects of the power adapter or USB adapter are not covered by the warranty.

Figure 3.1 Power Supply and 485 converter

3.3.1 Power Adapter

To ensure the proper operation of the product, it is recommended to use a high-quality 24V DC power adapter for power supply. When multiple products share the same power adapter, it is essential to ensure that the power is sufficient (the peak current of a single instrument is 300mA, and the rated current is 100mA). Overloading will cause abnormal output voltage of the power adapter, and the abnormal supply voltage may result in the product failing to operate normally or even being damaged.

3.3.2 USB Adapter

To minimize the risk of the device damage, when connecting to the RS232 communication interface, it is recommended to use an USB to RS232 protocol converter with an optically isolated interface.

3.4 Serial Communication

3.4.1 RS-485 Connection

The communication protocol adopts the Modbus_RTU mode, and the RS-485 interface requires the following settings to communicate normally with the device.

Baud rate：19,200
Data bit：8
Stop bit：1
Calibration：None
Flow control: None

3.4.2 RS232 Connection

For the command line protocol, RS232 interface requires the following settings to communicate normally with the device.

Baud rate：19,200
Data bit：8
Stop bit：1
Parity：None
Flow control：None

Ensure a secure connection between the communication device and the transmitter. The transmission signal (TxD) from the device should be connected to the reception signal (RxD) on the computer, and the reception signal on the device should be connected to the transmission signal (TxD) on the computer.

3.5 Real Time Clock

The transmmiter's real-time clock is equipped with a backup battery, which can maintain power for approximately one month when external power supply is cut off. After installation, please first use the RS command (Section 6.10) to set the real-time. The real-time data and time will be displayed in the data stream. For more information about these commands, refer to Section 6.

4. Mechanical Installation and Precautions

4.1 Precautions

Warning: Before installation and using the transmitter, please ensure the installation environment to meet the following conditions and requirements.

1. Avoid the accumulation of foreign objects such as mental fragments near the transmitter chip, as this may affect the transmitter’s performance in the future.
2. Ensure that the hydrogen concentration in the measured medium does not exceed the transmitter’s range, otherwise, the transmitter may be damaged.

3. Ensure that there is no liquid water or liquid conductive medium in the measured medium, otherwise, the transmitter may be damaged.
4. Try to keep the flow rate of the measured medium from exceeding2L/min, as an excessively fast flow rate may affect the measurement accuracy.
5. Use a standard torque wrench with an approximately 50N•m for 1/2" ferrule fitting, and do not over –tighten the ferrule nut.

4.2 Mechanical Connection

The test pipeline should be reserved with a 1/2 inch ferrule interface. The transmitter is installed and sealed through the ferrule interface. Note that the torque should not exceed 50N•m when tightening the ferrule nut. The transmitter is connected in series in the gas path through the inlet and outlet pipelines, as shown in the figure below.

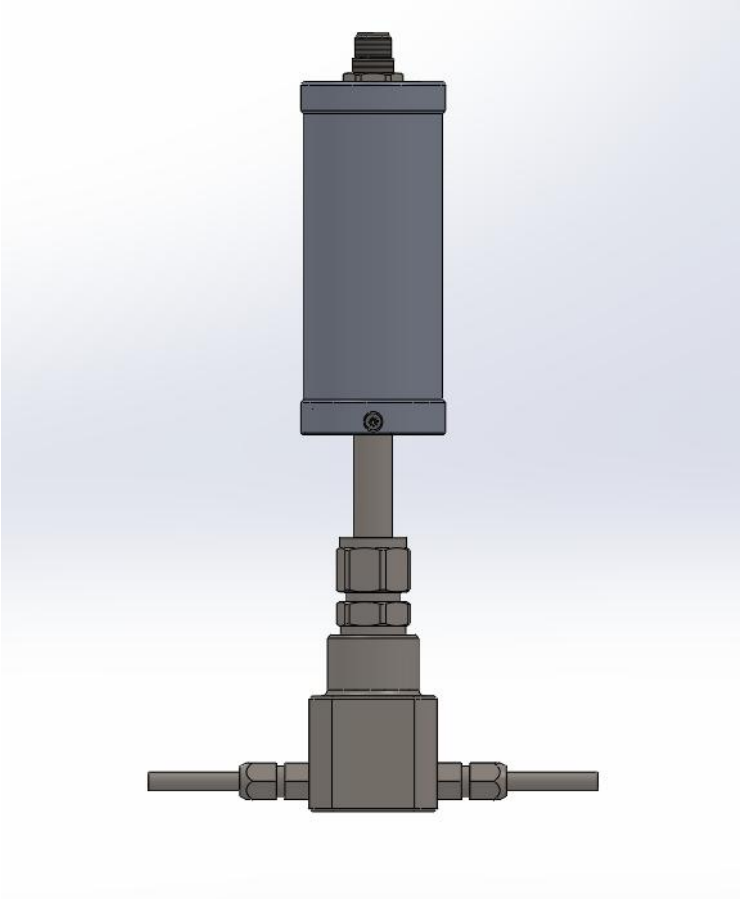


Figure 4.1 Installation and Connection Diagram

5. Operation

5.1 Startup

1. Please confirm the following items before startup:
   - For cables not connected to the transmitter, refer to Section 3.3 for wiring.
   - Ensure correct power supply voltage (24V DC).
   - If an RS232 serial cable is used to connect to PC, RS command must be used (section 6.10) to calibrate current time.
2. After connecting the cable and turning on the power supply, the transmitter will preheat. During the preheating process, the following operations will be preformed:
   - Power-on reset information is sent to the serial port.
   - System self-test is performed.
   - Configuration settings are restored from the flash memory.
   - The sampling system is activated to measure hydrogen and oil temperature.
3. When re-powering the product, the power cable must be disconnected for at least 15 seconds to ensure that the internal backup power supply is fully depleted.
4. For newly installed product, the IS command (Section 6.9) should be used to initialize the product. At this point, previous data will be deleted, and previous settings will be restored to the factory default values.
5. To ensure the normal operation of the device, the following command should be executed:

   Type D1↵ to display device information.
6. If conditions permit, it is recommended that users perform online calibration

of the transmitter according to the hydrogen calibration method in Chapter 7, Section 7.1.1.

5.2 Data Display

The measured hydrogen concentration is displayed in the H2AG.ppm column of the command line (on the RS232 port). During hydrogen measurement, a data line containing the hydrogen concentration and several other measured values is transmitted every 10 seconds.

The product has the following 4 operating characteristics:

1. The commands DA and DB (Sections 6.4 and 6.5) can be used to calibrate hydrogen in oil. The command DX (Section 6.6) can be used to clear calibration data.
2. The built-in data log memory can store up to 109,945 sensor data records. For more details on using the data log, refer to the command T in Section 6.11.
3. A real-time clock log that includes date and time.

5.3 User Configuration

There are no special requirements for the product's operation and output settings, and the default factory settings apply. Users can also make adjustments via the host computer or the following commands:

- **Command H: Modify the hydrogen concentration range (Section 6.8)**
- **Command A: Modify the relay trip point (Section 6.2)**
- **Command RS: Modify the real-time clock (Section 6.10)**

6. Command Line Debug Interface

6.1 Command Summary

Any character or command entered must be followed by the "Enter key". If no command string is entered, pressing any key will have no effect and an error message will be returned.

User Command	
Command	Function Descrption
A	Alarm settings
D <Page number> （ There is a space between "D" and the page number. ）	Display product information. Enter a page number from 0 to 3; the default page is 1. 0– Product information 1– User configuration 2– Production information 3– Product configuration
DA	Hydrogen-in-oil Calibration Step A
DB	Hydrogen-in-oil Calibration Step B
DX	Clear hydrogen-in-oil calibration data
G	Display product data columns
H	Modify hydrogen concentration reporting range
IS	Initial installation command (stored data will be cleared)
RS	Set date/time
T	Display or clear alarm data logs
X	Restore factory parameter settings
MI	Set Modbus product ID
MS	Switch between user mode and laboratory mode
DATA	Read historical data
CL	Program upgrade
CT	Calibration of oil temperature, pressure and moisture
LOG	Historical event information

6.2 Command A

Modify the alarm set points to monitor the following conditions:

1. Hydrogen concentration
2. Daily change rate of hydrogen concentration
3. Medium temperature

Example:

```
a
Relay #1 Select mode:
0 - Disable
1 - Hydrogen level
2 - Rate of Change
3 - OilTemp level
Select function: 1
Enter Trigger (ppm H2): 400          (CRLF)
Relay #1 Trigger (ppm H2): 400
...Wait...SAVED  Done......

Relay #2 Select mode:
0 - Disable
1 - Hydrogen level
2 - Rate of Change
3 - OilTemp level
Select function: 2
Enter Trigger (ppm H2/day): 400          (CRLF)
Relay #2 Trigger (ppm H2/day): 400
...Wait...SAVED  Done......

Relay #3 Select mode:
0 - Disable
1 - Hydrogen level
2 - Rate of Change
3 - OilTemp level
Select function: 3
Enter Trigger (Oil temperature): 80          (CRLF)
Relay #3 Trigger (Oil Temperature): 80
...Wait...SAVED  Done......
```

6.3 Command D

Display product information. Enter a page number from 0 to 3; the default page is 1.

0 – Product information

1 – User configuration

2 – Production information

3 – Product configuration

Example:

```
D 0
Product information:
Model Number : 3200
Serial Number: D0004
Sensor model : 4WRes
Firmware Rev : 1.83
Hardware Version: V3
Latest Calibration
  Factory: 20190322
  Field: 2019-3-22

D 1
User configuration is:
Hydrogen reporting range(in oil LowH2Range-HighH2Range):  0.00 - 5000.00ppm H2
Voltage Output is disabled
Isolated Output is enabled: 4.0mA to 20.0mA (LowH2Current-HighH2Current)
Error output is: 3.5mA
Not-Ready output is 2.0mA
Relays#1:enable
Relays#2:enable
Relays#3:enable
(relays#1) threshold is 400 ppm Hydrogen
(relays#2) threshold is 400 ppm Hydrogen/Day
(relays#3) threshold is 80 degrees Celsius
Pressure compensation is disabled
Gas Pressure is 1.0 atm
LabTest:enable

D 2
Manufacturing information is:
Sensor Serial Number: S2.3.01539
Sensor Board Serial Number: 200V4
Interface Board Serial Number: 17A20SV301141
Date Built: 20190322

D 3
Product Configuration:
Sample rate is 0:0:30/sample (times/sample)
```

6.4 Command DA

Hydrogen-in-oil Calibration Step A: This command saves the current hydrogen concentration reading of the product, which is used by the DB command to adjust the product's readings.

Example:

```
DA
Current H2 value is 0 ppm H2
```

6.5 Command DB

Hydrogen-in-oil Calibration Step B: This command uses the information saved by the

command DA and the actual hydrogen concentration in oil to adjust the product's readings. The current hydrogen reading will be adjusted immediately upon execution of this command.

Example:

```
DB
Enter actual hydrogen in ppm: 200
Set hydrogen to 200 ppm (Y/N)?Y
Calibration Gas finished
Cal. date is: 2018-1-1 (Y/N)?Y
 Enter Year:  2019
Enter Month: 3
Enter Day: 22
Cal Message:......
Cal. date : 2019-3-22
 Calc function is quited......
```

6.6 Command DX

This command will immediately clear the hydrogen-in-oil calibration data.

Example:

```
DX
Returns to last factory Calibration data (Y/N)?y
Cal Message:......
Returns to last factory Calibration data
Cal. date : 2019-3-22
```

6.7 Command G

Display the column headers of product data.

Example:

```
G
TimeStamp           PcbTemp  H2AG.ppm  OilTemp  H2DG.ppm  H2G.ppm  H2SldAv
DayROC  WeekROC  MonthROC  ;Message
2019-3-22 10:00:00  33.86     12        18.58     1         0.8      0
0       0        0         ;wait
```

6.8 Command H

Modify the hydrogen concentration reporting range. In this command, hydrogen concentration is expressed as % H_2. The conversion relationship between % H_2 and ppm H_2 is as follows:

% H_2 = ppm H_2 / 10,000

Example:

```
H
Hydrogen reporting range(in oil LowH2Range-HighH2Range):  0.00 - 5000.00ppm H2
Change (Y/N)?Y
Enter new LowH2Range: 100
Enter new HighH2Range: 4000
New hydrogen reporting range(in oil LowH2Range-HighH2Range): 100.00 - 4000.00ppm
H2
...Wait...SAVED - Done
```

6.9 Command IS

Initial installation command (stored data will be cleared)

Example:

```
IS
Erase All Data Log
...wait...              (Wait for a few seconds)
System time is 2018-1-1 0:0:0 Change (Y/N)?Y
Enter Year: 2019
Enter Month: 3
Enter Day: 22
Enter Hour: 10
Enter Minute: 0
Enter Second: 0
Change time to 2019-3-22 10:0:0
...Wait...SAVE TO RTC - Done
```

6.10 Command RS

Set the date and time of the product

Example:

```
RS
System time is 2018-1-1 0:0:0 Change (Y/N)?Y
Enter Year: 2019
Enter Month: 3
Enter Day: 22
Enter Hour: 10
Enter Minute: 0
Enter Second: 0
Change time to 2019-3-22 10:0:0
...Wait...SAVE TO RTC - Done
```

6.11 Command T

Display or clear alarm data records.

Example:

```
T
Trace Functions:
c = clear log
d = display log
e = exit
Select function: D
Enter Number of entries to show (max.999 alarm log): 888
0:
Begin Log Data - RS232

TimeStamp           H2DG_ppm  OilTemp  DayROC_ppm  Msg

End Log Data - RS232

T
Trace Functions:
c = clear log
d = display log
e = exit
Select function: C
Erase the Data Log (Y/N)?Y
All clear

T
Trace Functions:
c = clear log
d = display log
e = exit
Select function: E
exit
```

6.12 Command X

This command can restore the product parameter settings to the factory settings, including the hydrogen concentration range, but excluding modifications to the hydrogen-in-oil calibration.

Example:

```
X
Clear field calibration values (Y/N)?Y
Returns to last factory calibration data
Done - Wait......
```

6.13 Command MI

Set Modbus ID. The default ID is 1, which can be changed by setting the network communication protocol register 150 or using the command MI.

Example:

```
MI
Modbus ID is 1 Change (Y/N)?Y
Set Modbus ID to: 2
New Modbus ID is 2
Saved - Done
```

6.14 Command MS

The command MS is used to switch between user mode and laboratory mode. After using the command MS, the product needs to be powered on again to take effect.

The current mode can be checked using the command D1: if "LabTest" displays "enable", it indicates that the current mode is "test mode"; if it displays "disable", it indicates that the current mode is "working mode".

Example:

```
MS
LabTest mode is disabled Change (Y/N)?Y
Save as Default (Y/N)?
Y
Saved - Done
D 1
User configuration is:
Hydrogen reporting range(in oil LowH2Range-HighH2Range):  0.00
- 5000.00ppm H2
Voltage Output is disabled
Isolated Output is enabled: 4.0mA to 20.0mA
(LowH2Current-HighH2Current)
Error output is: 3.5mA
Not-Ready output is 2.0mA
Relays#1:enable
Relays#2:enable
Relays#3:enable
(relays#1) threshold is 200 ppm Hydrogen
(relays#2) threshold is 100 ppm Hydrogen/Day
(relays#3) threshold is 55 degrees Celsius
Pressure compensation is disabled
Gas Pressure is 1.0 atm
LabTest:enable
```

6.15 Command DATA

The command DATA is used to read the historical data of the device. The stored data

mainly includes timestamps, hydrogen concentration and oil temperature. The default storage interval is 30 seconds, and a maximum of 109,945 records can be stored. When the number exceeds 109,945, the earliest data will be automatically overwritten.

Example:

```
DATA
Trace Functions:
c = clear log
l = display log to rs232
m = display log to rs485
e = exit
Select function: L
Enter Number of entries to show (Max.109945 Record Log): 5

(Space Under Full)Total number of records: 11500, Display: 5
Begin Log Data - RS232

TimeStamp           H2DG_ppm  OilTemp  DayROC_ppm  Msg
2025-05-17 11:09:57     0     29.33        0      ;
2025-05-17 11:09:33     0     29.29        0      ;
2025-05-17 11:08:57     0     0.00        0      ;
2025-04-23 14:32:30    13     31.41        0      ;
2025-04-23 14:32:00    13     31.45        0      ;
End Log Data - RS232
```

6.16 Command CL

Command CL is used for program upgrading.

```
CL
Download new firmware (Y/N)?Y
Ready.... Flash Magic ...Send Hex file... >
```

6.17 Command CT

The command CT is used for the calibration of oil temperature, pressure, and moisture. Specifically, using command 2 is for oil temperature calibration, command 3 for pressure calibration, and command 4 for moisture value calibration.

```
CT
Out temperature or pressure Select calibration:
0 - Hydrogen Sensor TempCL
1 - Pressure Sensor TempCl
2 - Water Sensor TempCl
3 - Pressure Sensor ValueCl
4 - Moisture ValueCl
5 - Delete All Calibration Data
6 - Exit
```

```
Select function: 2
Water Sensor Temperature : 29.15C
Enter Actual Water Sensor Temperature :  29.15
Water Sensor Temperature Adi: -0.07C
...Wait...SAVED  Done......
Select function: 3
Pressure Sensor Value : 111.00Kpa
Enter Actual Pressure Sensor Value :  111
Pressure Sensor Value Adi: -0.03Kpa
...Wait...SAVED  Done......
Select function: 4
Moisture value : 42.23C
Enter Actual Moisture value :  42.23
Moisture Value Adi:  0.00C
...Wait...SAVED  Done......
```

6.18 Command LOG

The command LOG is used to read the historical event information of the device, including events such as power-up restart, abnormal status, and over-threshold alarm.

```
log
Trace Functions:
c = clear log
d = display log
e = exit
Select function: d
Enter Number of entries to show (Max. 779 Log): 50
Total number of records: 33, Display: 33
Begin Log Data - RS232
TimeStamp          Event
2025-05-17 11:14:17  Power-On RST
2025-04-22 16:32:09  Power-On RST
2025-04-22 16:25:10  Power-On RST
2025-04-22 13:25:40  Power-On RST
2017-05-01 18:38:58  Power-On RST
2017-04-30 16:59:49  Error_10
2017-04-30 15:09:08  Power-On RST
2017-04-27 22:04:29  Power-On RST
2017-04-27 22:02:50  Power-On RST
```

7. Maintenance

7.1 Calibration

Comparing the readings of the product with the standard gas can be used to check and adjust the measurement accuracy of the product.

Warning: Entering an incorrect value or using incorrect results with the command DB may cause errors in hydrogen readings, and may also result in failure to detect dangerous hydrogen readings in a timely manner.

7.1.1 Standard Gas Calibration

Pass standard gas into the transmitter. After the transmitter data stabilizes, send the command DA when the transmitter is in normal working condition. The product will save the current state for subsequent calibration. The product accuracy can be corrected using the command DB, which will immediately adjust the current hydrogen reading.

The input of commands DA, DB and standard values can be implemented via RS232 command line or RS485 Modbus protocol.

7.1.2 Medium Temperature Calibration

When a pressure or humidity sensor is integrated, the medium temperature can be measured. Temperature calibration can be implemented via the RS232 command line, and the specific method is detailed in section 6.17 ‘ Command CT ‘.

7.1.3 Factory Calibration

If necessary, the product can be returned to the factory for calibration by contacting manufacturer. A corresponding service and material fee will be charged for this service.

7.2 Servicing/Repair

There are no user-serviceable parts in the product. If the product is damaged or inoperable, please contact the manufacturer's after-sales service. Any repair costs incurred due to reasons not related to the product's own quality issues shall be borne

by the customer.

7.3 Warranty Period

The warranty period for the MODEL 5000 series products is 1 year. From the date of the user's receipt of the goods, within 1 year, our company shall be responsible for free repair or replacement of new products for product problems caused by product material, component or software faults.

8. Modbus_RTU Protocol

8.1 Brief Introduction

Modbus-RTU communication protocol adopts RS-485 master-slave half-duplex communication in terms of hardware. The master calls the slave address, and the slave responds to the communication.

Baud Rate	19200bps	Default baud rate. If modification is required, please contact the manufacturer.
Parity bit	N	
Data bit	8	
Start bit	1	
Stop bit	1	
Maximum response time	10 seconds	It integrates a pressure or micro-water sensor, and the host timeout setting must be no less than 10 seconds.

8.2 Supported Function Codes

Function Codes

Function Code	Function	Access Instructions
0x03	Read register	byte、short、float
0x06	Set single register	byte、short

8.3 MODBUS Protocol Format

8.3.1 Reading Registers and Its Response

The request information specifies the slave address to be read, function code, starting address of holding registers, number of holding registers, and CRC check. The starting address for holding register addressing is 0000H.

0x03 Reading Registers Format:

Byte	Parameter	Range	Definition
1	Slave Address	1-247	*Slave ID Address
2	Function Code	03	Read the binary data of holding registers
3	Starting Address of Holding Register Hi	0x00-0xFF	Holding register address High byte
4	Starting Address of Holding Register Lo	0x00-0xFF	Holding register address Low byte
5	Number of Holding Registers Hi	0	Number of Holding Registers High byte
6	Number of Holding Registers Lo	1-125	Number of Holding Registers Low byte
7	CRC Lo	0x00-0xFF	CRC Low byte
8	CRC Hi	0x00-0xFF	CRC High byte

* Slave ID Address: The MODBUS 8-bit RTU specifies that the slave address range is 0~247, where 0 is the broadcast address, and 248~255 are reserved.

0x03 Reading Registers Response Format:

Byte	Parameter	Range	Definition
1	Slave Address	1-247	Slave ID Address
2	Function Code	03	Return the binary data of holding registers
3	Total number of bytes	7-255	*Number of returned data bytes
4	DATA1 Hi	0x00-0xFF	First data value High byte
5	DATA1 Lo	0x00-0xFF	First data value Low byte
6	DATA2 Hi	0x00-0xFF	Second data value High byte
7	DATA2 Lo	0x00-0xFF	Second data value Low byte
…	…		
…	…		
2N+4	CRC Lo	0x00-0xFF	CRC Low byte

2N+5	CRC Hi	0x00-0xFF	CRC High byte

* Number of returned data bytes: If the number of holding registers queried is N, the number of returned bytes will be 2*N + 5.

8.3.2 Writing a Single Register and Its Response

0x06 Writing a Single Register Format:

Byte	Parameter	Range	Definition
1	Slave Address	1-247	Slave ID Address
2	Function Code	06	Writing holding register
3	Holding Register Address Hi	0x00-0xFF	Holding Register Address High byte
4	Holding Register Address Lo	0x00-0xFF	Holding Register Address Low byte
5	DATA Hi	0x00-0xFF	Data value High byte
6	DATA Lo	0x00-0xFF	Data value Low byte
7	CRC Lo	0x00-0xFF	CRC Low byte
8	CRC Hi	0x00-0xFF	CRC High byte

0x06 Writing a Single Register Response Format:

Byte	Parameter	Range	Definition
1	Slave Address	1-247	Slave ID Address
2	Function Code	06	
3	Holding Register Address Hi byte	0x00-0xFF	Holding Register Address High byte
4	Holding Register Address Lo byte	0x00-0xFF	Holding Register Address Low byte
5	DATA Hi byte	0x00-0xFF	Data value High byte
6	DATA Lo byte	0x00-0xFF	Data value Low byte
7	CRC Lo	0x00-0xFF	CRC Low byte
8	CRC Hi	0x00-0xFF	CRC High byte

8.3.3 Exception Response

Exception Response Format

Command	
Byte	Parameter Description
1	Slave Address

2	Function Code | 0x80
3	Exception Code
4,5	CRC Check

Exception Code

Code	Name	Description
01	Illegal function code	Invalid function code
02	Illegal data address	Address not allowed by slave
03	Illegal data value	Invalid data length

Applicable to MODEL5000 series						
Register Address (Decimal)	Register Address (Hexadecimal)	Register Description		Data Format	Unit	Read/ Write
0~3	0x00~0x03	Reserved				
4	0x04	H2 Concentration	High byte	32-bit integer	PPM	R
5	0x05		Low byte			
6	0x06	Sensor Temperature	x100-100，T=(V/100-100)	16-bit integer	℃	R
7	0x07	CPB Temperature	x100-100，T=(V/100-100)	16-bit integer	℃	R
8	0x08	Medium Temperature（with pressure compensation）	x100-100，T=(V/100-100)	16-bit integer	℃	R
9~30	0x09~0x1E	Reserved				
31~40	0x1F~0x28	Product Model		ASCII String		R
41~50	0x29~0x32	Product Number		ASCII String		R
51~60	0x33~0x3C	Core serial number		ASCII String		R
61~70	0x3D~0x46	Core Batch		ASCII String		R
71~80	0x47~0x50	CPB number		ASCII String		R
81	0x51	Production Date	Month Day			R
82	0x52		Year			
83	0x53	Manufacturer's calibration date	Month Day			R & W
84	0x54		Year			

85	0x55	On-site calibration date	Month Day			R & W
86	0x56		Year			
87	0x57	Hydrogen calibration date (1)	Month Day			R & W
88	0x58		Year			
89~98	0x59~0x62	Software version number		ASCII String		R
99	0x63	Historical data read count setting	High byte	32-bit integer		R
100	0x64		Low byte			
101	0x65	Historical data read start flag	Output starts after writing 1001	16-bit integer		W
99~110	0x63~0x6E	Reserved				
111	0x6F	Device status bit	See Table 8.1	16-bit binary flag bit		R
112~120	0x70~0x78	Reserved				
121	0x79	DA Command Line(1)	1. After writing 0x01 to register 121, start introducing the standard gas for the first point and wait for the response to stabilize. 2. First, write the concentration of the introduced standard gas to registers 126~127, then write 0x11 to register 121 to immediately execute calibration. If the calibration is successful,	16-bit integer		R & W

			register 121 will be set to 0x10. 3. After the first point calibration is completed, if a 2-point calibration is required, register 121 must be set to 0x02 before introducing the standard gas for the second point.			
122	0x7A	DB Command Line(1)	1. First, the value of register 121 must be 0x02, meaning the 2-point calibration state has been set. 2. After writing 0x01 to register 122, start introducing the standard gas for the second point and wait for the response to stabilize. 3. First, write the concentration of the introduced standard gas to registers 126~127, then write 0x11 to register 122 to immediately execute calibration. If the calibration is successful, register 122 will be set to 0x10.	16-bit integer		R & W

123	0x7B	DX Command Line	Writing 1 will clear the calibration data, and writing 2 will restore the factory settings.	16-bit integer		R & W
124~125	0x7C~0x7D	Reserved				
126	0x7E	Standard gas concentration(2)	High byte	32-bit integer	PPM	W
127	0x7F		Low byte			
128	0x80	Current calibration date	High byte	32-bit integer		W
129	0x81		Low byte			
130	0x82	Month、Day(RTC)		BCD code		R & W
131	0x83	Year(RTC)		BCD code		
132	0x84	Hour(RTC)		BCD code		
133	0x85	Minutes Second(RTC)		BCD code		
134~140	0x86~0x8C	Reserved				
141	0x8D	setting of hydrogen measurement lower limit	High byte	32-bit integer	PPM	R & W
142	0x8E		Low byte			
143	0x8F	setting of hydrogen measurement upper limit	High byte	32-bit integer	PPM	R & W
144	0x90		Low byte			
145~149	0x91~0x95	Reserved(232\485)				
150	0x96	setting of slave address		16-bit integer		R & W
151	0x97	setting of device operating mode		16-bit integer		R & W

152	0x98	hydrogen concentration alarm value (1)	High byte	16-bit integer	PPM	R & W
153	0x99		Low byte			
154~160	0x9A~0xA0	Reserved				
161	0xA1	Pressure value of integrated pressure sensor (3)	High byte	32-bit floating-point type (storage order: CDAB)	KPa	R
162	0xA2		Low byte			
163	0xA3	Temperature value of integrated humidity sensor (3)	High byte	32-bit floating-point type (storage order: CDAB)	℃	R
164	0xA4		Low byte			
165	0xA5	Water content of integrated humidity sensor (3)	High byte	32-bit floating-point type (storage order: CDAB)	PPM	R
166	0xA6		Low byte			
167	0xA7	Relative humidity in oil of integrated moisture sensor (3)	High byte	32-bit floating-point type (storage order: CDAB)	%	R
168	0xA8		Low byte			
169~174	0xA9~0xAE	Reserved				
175	0xAF	Running time	Highest byte	64-bit integer	Second	R
176	0xB0		High byte			
177	0xB1		Low byte			
178	0xB2		Lowest byte			
179~200	0xB3~0xC8	Reserved				
201~210	0xC9~0xD2	User ID		ASCII String		R
211~220	0xD3~0xDC	User ID		ASCII String		R
221~230	0xDD~0xE6	User ID		ASCII String		R

231~255	0xE7~0xFF	Reserved

Table 8.1 Device Status Bit

Bit Number	Function Description	Status Description
15	Device ready	1：Ready 0：Not ready
14	Reserved	
13	Reserved	
12	Sensor abnormal and cannot self-recover	1：Abnormal 0：Normal
11	Sensor hydrogen sensitivity (fault) – Status 1 indicates activation	1: Fault 0：Normal
10	Sensor thermal sensitivity (fault) – Status 1 indicates activation	1: Fault 0：Normal
9	Sensor heating (fault) – Status 1 indicates activation	1: Fault 0：Normal
8	Sensor pressure (fault) – Status 1 indicates activation	1: Fault 0：Normal
7	Reserved	
6	Relay 3 (ambient temperature) – Status 1 indicates activation	1：Alarm 0：Normal
5	Relay 2 (daily change rate) – Status 1 indicates activation	1：Alarm 0：Normal
4	Relay 1 (hydrogen) – Status 1 indicates activation	1：Alarm 0：Normal
3	Reserved	
2 1 0	Sensor status information: 0 - Sensor unavailable 1 - Operating normally and measuring 2 - Measuring ambient temperature 3 - Calibration mode 4 - Circuit board temperature exceeds the sensor's operating temperature 5 - Ambient temperature exceeds the sensor's operating temperature 6 - Measurement data unavailable or self-locked	Sensor status information: 000 - Sensor unavailable 001 - Measuring hydrogen concentration 010 - Measuring ambient temperature 011 - Calibration mode 100 - Circuit board temperature overrun 101 - Ambient temperature overrun 110- Data self-locked (can be automatically unlocked and restored)

Attachment: Hydrogen Calibration Method for Model 5000 Series Sensors (using the "Hydrogen Calibration" software provided by our company)

1. Open the hydrogen calibration software, set the port number, baud rate, and ID number, then click the "Open Serial Port" button.
2. Select "M40 Calibration" in the left menu bar of the calibration software.
3. (step1): Choose "1-point calibration".
4. (step2): Ensure that the sensor is completely balanced in the standard gas, click the "Read" button to obtain the current concentration value.
5. (step3): After confirming that the sensor value is completely balanced, input the standard gas concentration value.
6. After calibration is completed, click the "Auto Read" button in the left menu (note: do not click the "Read" button on the calibration interface, otherwise data may be cleared), and click the "Auto Read" button below again to check whether the output has been calibrated to the set value. If there is any deviation, you can fine-tune the offline set value in step 5 and recalibrate.

Table 8.2 Methods for Reading Historical Data

Instructions for Reading Historical Data Stored in Sensors via RS485 Interface						
Reading Protocol						
Register Address (Decimal)	**Register Address (Hexadecimal)**	**Register Description**	**Data Format**	**Unit**		**Read/ Write**
99	0x63	Setting for the Number of Historical Data Reading Entries	High byte	32-bit integer		R
100	0x64		Low byte			

101	0x65	Start Flag for Historical Data Reading	Output starts after writing 1001.	16-bit integer		W

Table 8.3 Methods for Parsing Historical Data

Data Parsing					
Start Character (1 byte)	**Timestamp (7 bytes)**	**Hydrogen in Oil (4 bytes)**	**Oil Temperature (2 bytes)**	**Daily Change Rate of Hydrogen in Oil (4 bytes)**	**End Character (1 byte)**
0x5A	BCD code, in the order of year, month, day, hour, minute, second	32-bit integer	×100 scaling, +100 offset, 16-bit integer	32-bit integer	0xA5

Example: For Sensor ID1 to read 1000 (0x000003E8) entries of internal historical data, write operations are performed sequentially on individual registers as follows: 01 06 00 63 00 00 79 D4, 01 06 00 64 03 E8 C8 AB, 01 06 00 65 03 E9 58 AB. Response data: 5A 20 25 01 22 11 45 07 00 00 01 88 36 8F 00 00 00 0A A5.
Time: 11:45:07 on January 22, 2025, hydrogen concentration in oil: 392 ppm, oil temperature: 39.67℃, daily change rate of hydrogen in oil: 10 ppm

9 Serial Port Debugging Tool FoxTerm

9.1 FoxTerm Installation

1. Create a folder named "H2sense" in "My Documents" on the computer.
2. Download the FoxTerm software from the website: www.foxterm.net. Click the download option and save the latest file to the "H2sense" folder.
3. Unzip the FoxTerm file and save it to the "H2sense" folder.

9.2 FoxTerm Settings

1. Launch FoxTerm and close the default session window if necessary.

2. Click "File-New COM Port Connection" to open a new session window.
3. Select the correct port and baud rate. In this example, use COM2. The settings are as shown in Figure 9.21.
4. The "Newline Behavior" must be set to "CRLF".
5. Click "OK".
6. For data saving, right-click in the blank interface to bring up the session menu as shown in Figure 9.22, select "Logging Setup", and choose the storage path.

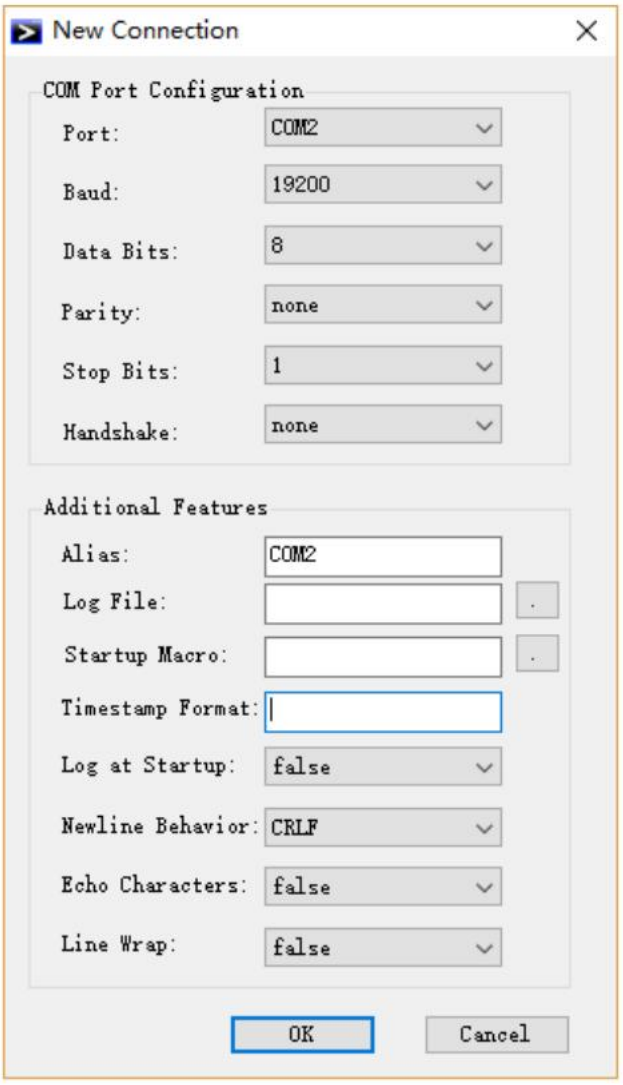


Figure 9.21 Foxterm Settings dialog box

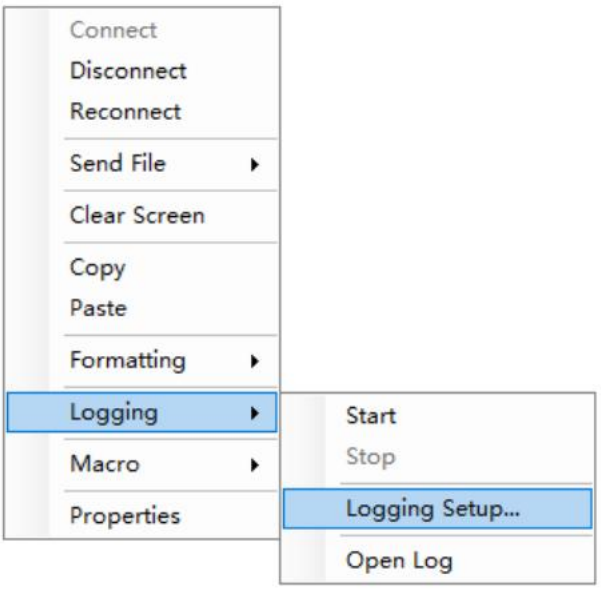


Figure 9.22 Foxterm Data Storage Settings Diagram