SPECIFICATION

Product Name: Industrial Grade NDIR CH4 Gas Sensor

Item No.: SJH-5B1

Version: V0.1

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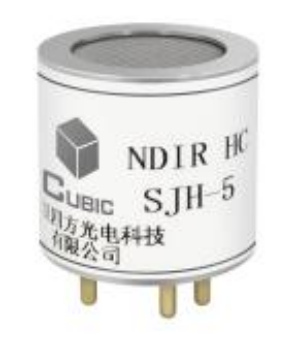
Revision

No.	Version	Content	Date
1	V0.1	1.Specification template	2021-12-25

Industrial Grade NDIR CH4 Gas Sensor
SJH-5B1



Applications

- ✧ High-humidity application scenarios such as gas well and valve well leak detection
- ✧ Environmental monitoring, gas drainage pipeline monitoring
- ✧ Combustible gas generation, storage and usage etc. indoor and outdoor easily emission dangerous locations

Description

SJH-5B1 is an industrial-grade gas sensor for real-time measurement of gas concentration changes. It is based on non-dispersive Infrared (NDIR) technology, has the advantages of good signal-to-noise ratio, strong selectivity, no cross gas interference, high precision, good long-term stability, and long life time compared to chemical and semiconductor technology.

SJH-5B1 is compatible with analog voltage and digital serial output at the same time, which can meet various needs of industrial field, laboratory measurement, etc. It is widely used in coal mines, pipeline monitoring, underground well, pressure regulating cabinet and other fields.

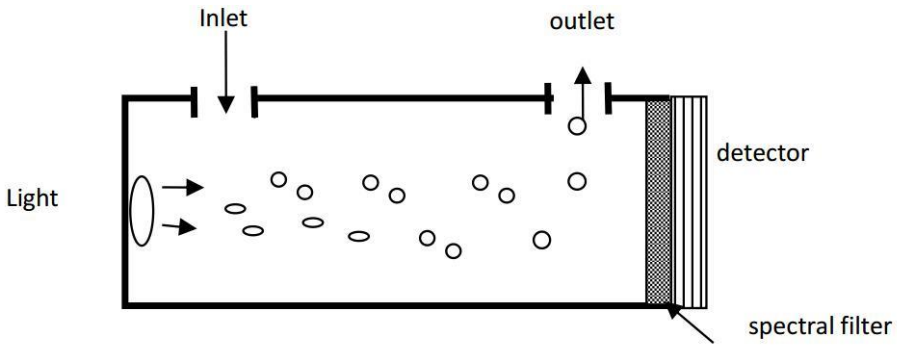
Main Features

- ✧ Shock-resistant IR source available, diffused gas sampling via mesh
- ✧ Resistant to high humidity and low power consumption
- ✧ Build-in/Embedded temperature and humility compensation and matrix calibration to ensure accuracy
- ✧ High humidity alert mechanism, reliable fail-safe operation
- ✧ Resistant to acetic acid ethanol gas interference
- ✧ Self-calibration optional
- ✧ Dust proof and waterproof IP64
- ✧ Compatible with digital and analog signal output
- ✧ Meet the explosion-proof level Ex ia IIC T4 Ga, certification No. GYB19.1789

Principle of Measurement

Non-Dispersive Infrared (NDIR) Principle

Molecule like CO_2 and CH_4 is composed of different types of atoms, it has absorption spectrum in infrared range. Absorption intensity abides by Lambert-Beer's Law. When light wave corresponded to certain gas with absorption spectrum passes through measured gas, the intensity of light wave will be significantly weakened. The intensity attenuation is related to concentration of measured gas. This relation follows Lambert-Beer's Law. Basic working principle of NDIR sensor is as below.



Basic mathematical model： A majority of both organic and inorganic polyatomic gas have specific absorptive wavelength in infrared region. When infrared light passed by, the light transmissivity of this gas molecule to certain wavelength can be expressed by Lambert-Beer Law:

I stands for light transmissivity, $I = I_0 e^{-kpl}$

i stands for light absorption intensity, $i = I_0 - I = I_0 (1 - e^{-kpl})$

I_0**:** incident light intensity.

l: thickness of gaseous medium

p: gas concentration

k: absorption coefficient

Technical Specification

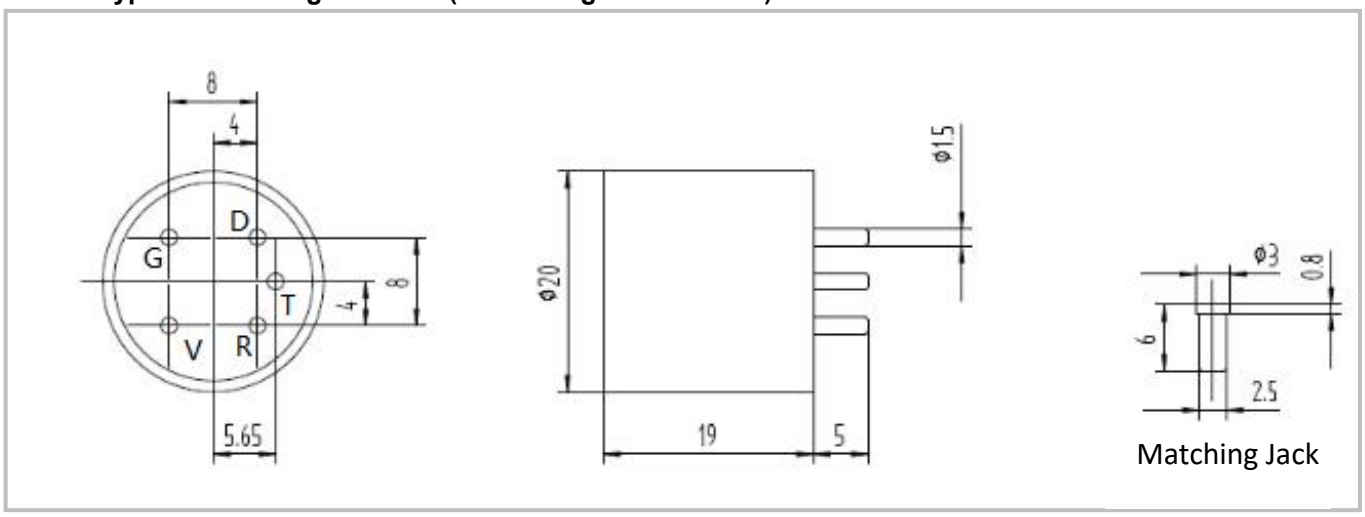
Sensor Type	**SJH-5B1**
Gas	Methane
Measurement Range	0~5%Vol
Accuracy[1,2]	0～1%: ±0.06%vol 1～2.5%: ±6% of Reading 2.5%～full range: ±6% of Reading
Resolution	0.01%
Maximum Response Time (T_{90})	<25s
Zero Repeatability[3]	±0.01% Vol
Full Scale Point Repeatability[3]	±0.03% Vol
Working Temperature	-40～70℃
Storage Temperature	-40～85℃
Working Humidity[4]	0-95%RH (Non-condensing)
Working Voltage	3.3～5.5VDC
Average Current per Working Cycle	<220mA (5V Input)@working cycle 80s
Peak Current	<500mA (5V Input)
Output Type	UART-TTL (2.5-3.3V) /Analog output (0.4-2V)
Serbaud	9600bps
Dimension	Φ20*16.6mm (Not include pin size)
Body material	Stainless Steel
Quantity of Pins	5 pin
Weight	15.6g
Life Span[5]	>10 years
Ex-proof Level	Ex ia IIC T4 Ga

1. The standard gas sample is provided by the unit certified by the national metrology department. All gases diluted in dry nitrogen; the required accuracy of dry nitrogen greater than 99.999%.
2. Performance defined above is after calibration. All Cubic sensor have 100% calibration in production.
3. After sensor stabilization and over a period of 8 hours and ambient temperature (20 ° C)
4. Humidity sensors have high humidity alert mechanism and reliable fail-safe operation: when relative humidity>95%, the light source is lit immediately, the sensor heats up to prevent condensation and protect itself, concentration output will be 0; when relative humidity <90%, high humidity abnormality alert quits, sensor will go back to normal work.
5. IR Source only and continuous working.

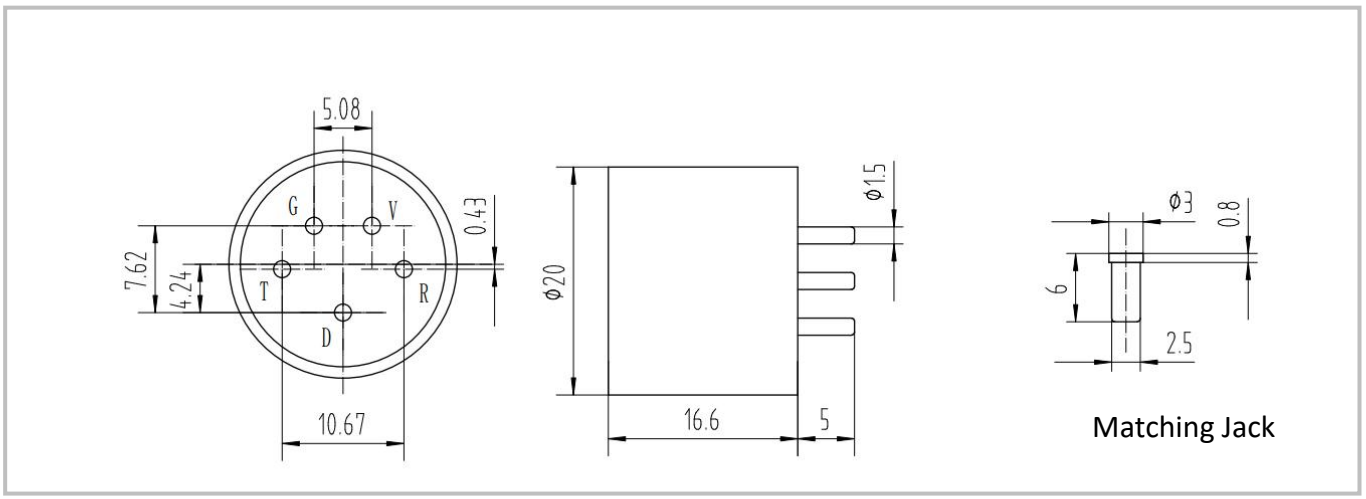
Configuration & Pin Definition

1. Appearance Size

Non-XD Type Sensor Height: 19mm (See Configuration Table)



XD Type Sensor Height 16.6mm (See Configuration Table)



2. Pin Definitions

Pin	Name	Description
V	Vi	Power Input（Vi：DC3.3V～5.5V（Recommend Vi=5V）
G	GND	Power Input Terminal (Ground Terminal)
T	TX	Serial Port Terminal (Circuit Board Serial Port Sender)
D	Vout	Analog Output Terminal
R	RX	Serial Port Terminal (Circuit Board Serial Port Receiver)

Appearance Size Notes

1. All dimensions in millimeters; dimensions without limits are nominal.
2. Body dimensional tolerances ±0.2 mm.

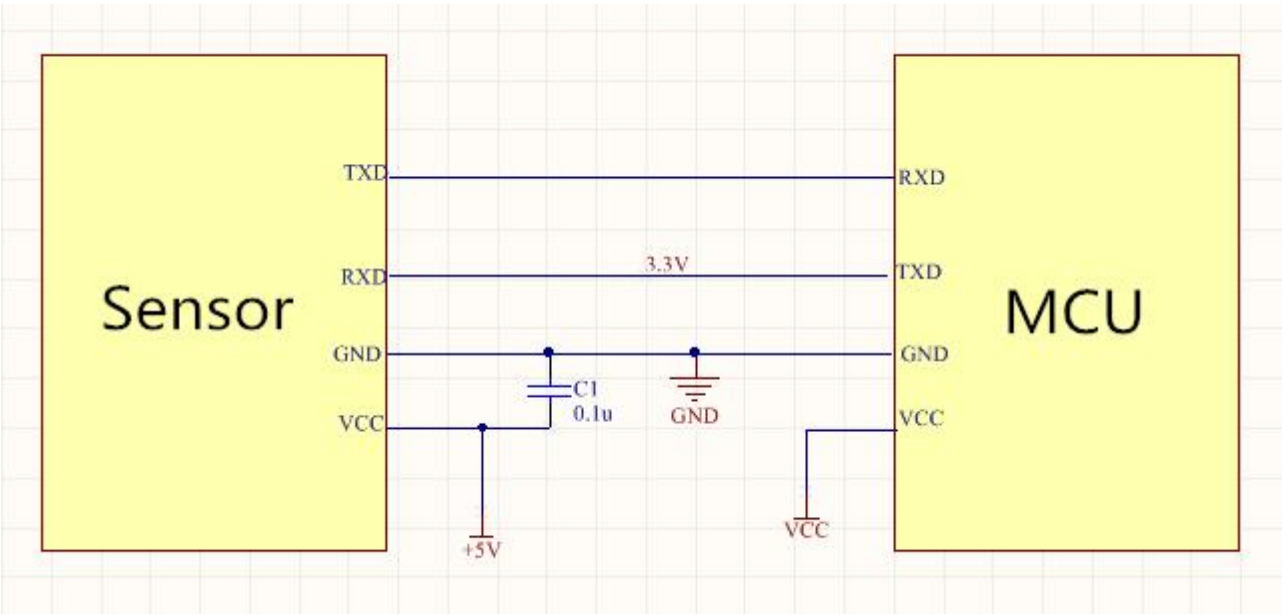
Typical Application Circuit Diagram

Application Scenario 1: UART Serial Port Output

External devices can communicate with sensors through UART.

3.3V device (CPU) can be connected with serial port pin RX and TX directly.

The interface circuit is as follows, reading gas concentration data or performing calibration function.



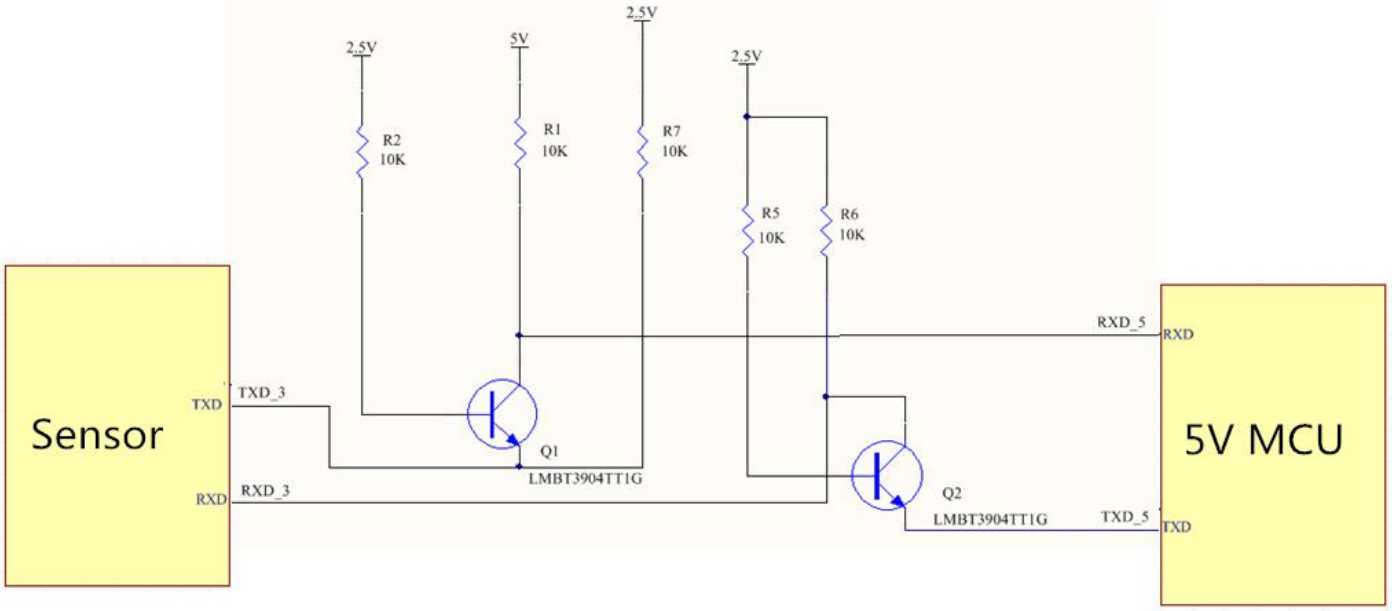
Picture 1: UART Communication Connecting Circuit

Typical Application Circuit Diagram

Application Scenario 2：5V-2.5V Level Switching Circuit

Sensor need to transform the voltage when connecting with 5V devices,

the interface circuit is as follows:



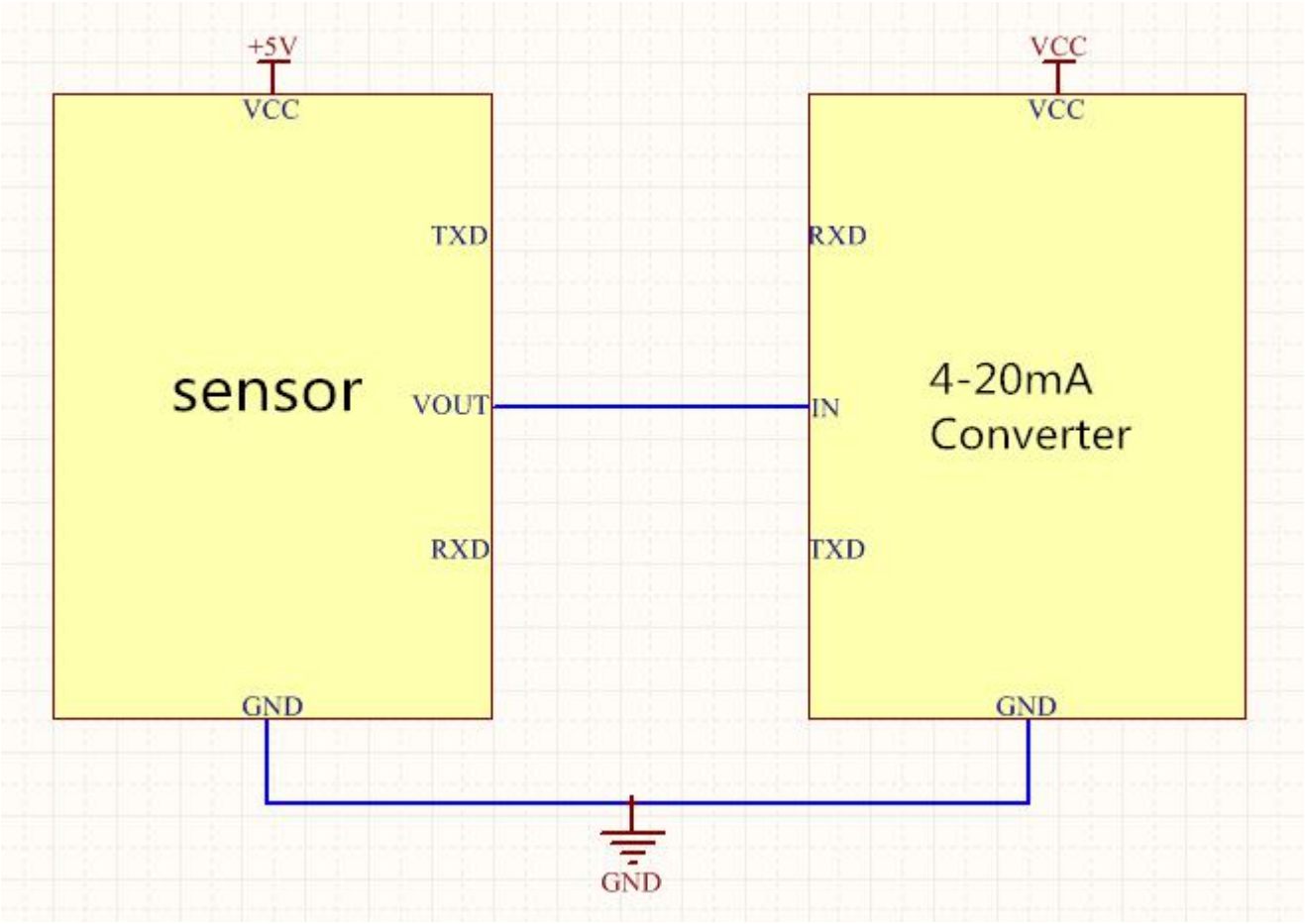
Picture 3: 2.5V Communication Level Converted to 5V Communication Level Circuit

Typical Application Circuit Diagram

Application Scenario 3：Analog Output

Sensor Pin D (Vout) output signal is 0-2.5V DC voltage, where 0.4-2.0V corresponding to 0-100% full range gas, the user can convert the voltage signal to industrial standard 4-20mA current signal through voltage current converter.

The interface circuit is as follows:



Picture 4: Analogue signal output circuit

Precautions for Use

1. The connecting cable shall be shielded cable with insulating sheath, and its shielding layer shall be grounded.

2. Users should not replace the components of this product without authority. To avoid damaging product, please kindly solve the problems in operation with our engineers.

3. Installation, use and maintenance of this product should comply with relevant provisions of product instruction,
   GB3836.13-1997 "Electrical equipment for explosive gas environment Part 13: Explosion Overhaul of electrical equipment for explosive gas environment ",
   GB3836.15-2000 "Explosive gas environmental electrical equipment Part 15: Electrical installation in hazardous places (coal) Mine)",
   GB3836.16-2006 "Explosive Gas Environmental Electrical Equipment Part 16: Inspection and maintenance of electrical installations (except coal mines)",
   GB50257-1996 "Electrical installation engineering explosion and fire hazard environment Electrical installation and acceptance specifications".

Communication Protocol

1.General Statement

1) The data in the protocol are all hexadecimal data, such as “46” is hexadecimal [70].

2) [xx] is single-byte data (no symbol, 0-255); (xx) is dual-byte data, signed integer (-32768 to +32767), the high-byte is ahead.

Note behind “--” is annotation.

3) The byte length of entire command is [LB]+3.

2. Communication Protocol Format

Send : [IP] [LB] [CMD] [DF] [CS]

[IP] address (fixed as 11)

[LB] followed byte length does not include CS

[CMD] command

[DF] the command with parameter items and optional items

[CS] CS= - (IP +LB+CMD +DF)

Response :

1 . When the command is implemented correctly, it responds

[ACK] [LB] [CMD] [DF] [CS]

[ACK] = 0X16 right command

[LB] followed byte length does not include CS

[CMD] command

[DF] the command with parameter items and optional items

[CS] CS= - (ACK +LB+CMD+DF)

2 . When the command is not implemented correctly, it responds

[NAK] [LB] [CMD] [EC] [CS]

[NAK]=0X06 Command is not implemented correctly

[LB]=2 byte length followed does not include CS

[CMD] command

[EC] the error code that command is not implemented correctly

[CS] CS = - (NAK +LB+CMD+DF)

[EC]

01 Order length is wrong or command cannot be resolved correctly

02 The command is not correct

03 Can’t implement this command under current status.

3. Function List

Number	Function Name	CMD	Function Description
1	Check the Measurement Result	0x01	
2	Zero Adjustment	0x03	
3	User Calibration		Used for Gas Calibration
3.1	Zero Point for User Calibration	0x4B	
3.2	Full Scale Point for User Calibration	0x4C	
4	Reset Factory Calibration Data	0x4D	
5	Check the Software Version	0x1E	
6	Check the Instrument Number	0x1F	
7	Check the Gas Measurement Property	0x0D	
8	Set the sensor working time	0x07	For periodic work scenarios

4. Detailed Description

1. Check the Measurement Result

Send： 11 01 01 ED

Response： [ACK] 05 01 [DF1] [DF2] [ST1] [ST2] [CS]

Function： check the measurement result

Remark：

1. Gas 1 concentration=（DF1*256+ DF2）/(100)，
2. [ST1] Sensor working status
3. [ST2] Reserved

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
1: Measurement Over Limit 0: Normal	1: Reference Over Limit 0: Normal	1: High Humidity 0: Normal	1: No calibration 0: Calibrated	Reserved	1: Outrange 0: Normal	1: Malfunction 0: Normal	1: Warming Up 0: Ready

The specific description and definition are shown in the following table:

BIT0	**Sensor Warm-up Status Sign** 1 Sensor is warming-up, concentration output is zero in 10s period of warming-up time. 0 Warm-up completed; output is normal concentration data.
BIT1	**Sensor Malfunction Status Sign** 1 Have malfunction, concentration output mandatory is 0. 0 Signal is normal, no malfunction. Sensor malfunction determination method: reference AD or measuring AD< 800, too low signal is considered a sensor failure.
BIT2	**Sensor Display Value Outrange Status Sign** 1 Sensor concentration display value exceeds the range. 0 Sensor concentration display value is within the display range.
BIT3	**Reserved, default is 0.**
BIT4	**Whether Sensor is Calibrated Sign** 1 No calibration, concentration output mandatory is 0. 0 Sensor calibrated
BIT5	**Sensor High Humidity Abnormality Alarm State Sign** 1 High humidity, concentration output mandatory is 0. 0 The sensor works within the normal humidity range. When relative humidity>95%, BIT5=1, the light source is lit immediately, the sensor heats up to prevent condensation and protect itself, concentration output mandatory is 0; when relative humidity <90%, quit high humidity abnormality alert, sensor work normally, BIT5=0.
BIT6	**Sensor Reference Channel Display Value Over Limit Status Sign** 1 Reference channel display value over limit, sensor has malfunction. 0 Reference channel display value within limit.
BIT7	**Sensor Measurement Channel Display Value Over Limit Status Sign** 1 Measurement channel display value over limit, sensor has malfunction 0 Measurement channel display value within limit

ST2 reserved.

2. Zero Adjustment

Send：11 01 03 EB

Response：[ACK] 01 03 [CS]

Function：

Remark： The instrument receives the zero adjustment command to correct the gas data of the instrument to zero point. Before the command is sent, the instrument must pass over zero air and the sensor indication is stable.

3. User Calibration

3.1 Zero Point for User Calibration (4B)

Send：11 04 4B [GasNum] [DF1] [DF2] [CS]

Response：[ACK] 01 4B [CS]

Function：Zero calibration for the gas

3.2 Full Scale Point for User Calibration (4C)

Send：11 04 4C [GasNum] [DF1] [DF2] [CS]

Response：[ACK] 01 4C [CS]

Function：make full scale point calibration for the gas

Remark：

1. [GasNum] is the gas calibration indicator, default 0.
2. The value of the calibration gas concentration = (DF1 * 256 + DF2)/（100）
3. Before executing this command, it's required to pass over the gas in accordance with the concentration range through the sensor, and send the command after the gas is stable (it can be judged by the result of checking command or when the gas flow through the sensor stably for a period). The two points for user calibration should be finished in a short time.

4. Calibration Data Recovery

Send：11 02 4D [GasNum] [CS]

Response：16 01 4D 9C

Function：

Description：

1 Restore user calibration data to the factory calibrated data, and the single point calibration value is cleared.

2 [GasNum] is the gas composition indicator, 0 means calibration of the first component, and 01 is the second component. The value range depends on the gas composition, and it is used for multi-channel sensor. Default is 0.

5. Check the Software Version

Send：11 01 1E D0

Response：[ACK] [x+1] 1E [CH1] [CH2] [CH3] ……[CHx] [CS]

Function：

Remark： Output the version number of software.

[CH1] - [CHx] is the version of software, which shows as ASCII code.

6. Check the Instrument Number

Send：11 01 1F CF

Response：[ACK] 0B 1F（SN1）（SN2）（SN3）（SN4）（SN5）[CS]

Function：

Remark：

Output the instrument serial number of software.

SNn range is 0~9999, the five integers form a 20-digit number.

7. Check the Gas Measurement Property

Send：11 01 0D E1

Response：[ACK] 08 0D [DF0] [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [CS]

Function：check the measurement range, decimal number, gas type, unit, etc.

Remark：

1 Measurement range=([DF0] *256+[DF1])/10^[DF2]

(10^ [DF2] means the corresponding multiple which is determined by the decimal places number [DF2] value)

2 The definition of gas type is as following：

[DF3]	Gas Type Description
0	CH_4
1	CO_2
2	CO
Others	Reserved

3 The definition of the unit is as following:

[DF4]	Unit Description
0	ppm
1	%
2	%
3	%

[DF5] [DF6] reserved

8. Set the sensor working time

Send: 11 03 07 DF1 DF2 [CS]

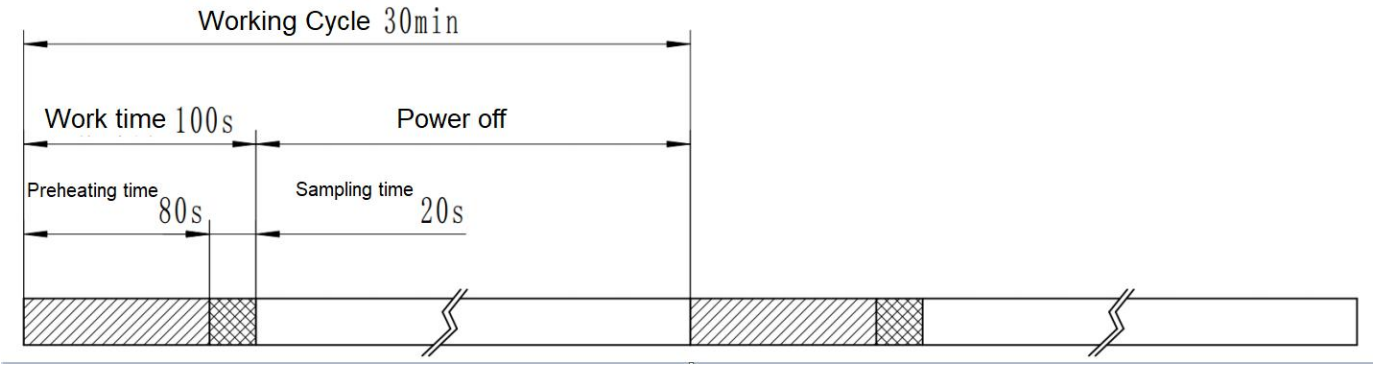
Response: 16 01 07 E2

Function: Set the working time of the sensor, the default time is 100s, this command does not need to be used for long-term power-on.

Remark:

1. Working cycle=[DF0]*256+[DF1]. The working time range is 60s-600s, after the working cycle is set, the sensor will preheat when power on, sampling is performed in the last 20s after preheating, and the sensor output concentration is not filtered within the 20s sampling time.

2. For example: the sensor is powered on for 100s every 30min, powered off at other times of the 30min, the sensor is preheated for 80s during the working time 100s, and the sensor sampling in 20s, as shown in the below figure. If the working time is 120s, the preheating time is 100s, and the sensor sampling time is 20s.



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