SPECIFICATION

Product Name: Industrial Grade NDIR Gas Sensor

Item No.: SRH, SJH, SBH, SBrH Series

Version: V0.4

Date: September 18, 2020

Revision

No.	Version	Content	Reviser	Date
1	V0.1	1.Specification template.	Mei Yang	2019-3-7
2	V0.2	1. In the technical parameters, the working voltage is changed from "3.5-6vdc" to "3.3-5.5vdc"; 2. The correction of 5v-2.5v level switching circuit in the circuit diagram is recommended.	Mei Yang	2019-6-6
3	V0.3	1.Amendment of company name.	Mei Yang	2019-8-28
4	V0.4	1. Update product specification. 2. Add UART-TTL to RS232 transfer in the circuit diagram.	Una Zhan	2020-9-18

Industrial Grade NDIR Gas Sensor
SRH, SJH, SBH, SBrH Series

SRH Series

Application

▪ Carbon dioxide gas leakage alarming

▪ CO_2 incubator

▪ Greenhouse

▪ Controlled-atmosphere (CA) storage, cold-chain

▪ MAP (modified atmosphere packaging) storage

▪ Underground garage

▪ Hydroponic culture

SJH Series

Application

▪ Mine, metallurgy, oil & gas

▪ LNG gas leakage alarming

▪ Gas concentration meter

▪ Organic solvent

▪ Liquefied gas station

▪ Fuel gas transport

SBH Series

Application

▪ Mine, metallurgy, oil & gas

▪ Gas leakage alarming

▪ LPG leak monitoring

▪ Refrigerant leak sensor

▪ Liquefied gas station

▪ Fuel gas transport

SBrH Series

Application

▪ Industrial Safety

▪ Fumigation

▪ Chemical

▪ Oil & gas

▪ Gas drainage monitoring

▪ Liquefied gas station

▪ Fuel gas transport

Description

Industrial grade NDIR gas sensors are adopted non-dispersive Infrared (NDIR) technology, made by advanced technology and elements, so they have splendid features and are widely used to detect concentration of CO_2, CH_4, C_3H_8, $CBrH_3$ in both industry and agriculture applications.

Industrial grade NDIR gas sensors can be easily integrated in safety and alarming devices, able to be used for intelligent agriculture, industrial safety, environmental monitoring, gas drainage pipes monitoring and other situations for CO_2, CH_4, C_3H_8, $CBrH_3$, such as chemical industry, petroleum, metallurgy, oil depot, liquefied gas station, gas transmission and distribution.

## Main Features

✧ For detection of the following gases:

　　Carbon Dioxide (SRH series),

　　Methane (SJH series),

　　Propane (SBH series),

　　Bromomethane (SBrH series)

✧ Multi-measurement range, with full range linearized and digital signal output

✧ Shock-resistant IR source available, diffused gas sampling via mesh

✧ Reference channel for self-compensation

✧ Build-in/Embedded temperature and humility compensation and matrix calibration to ensure accuracy

✧ High humidity alert mechanism, reliable fail-safe operation

✧ Auto zero-calibration mechanism available

✧ Fast response, no moving parts, high stability, anti-corrosion

✧ Multiple size options for different applications

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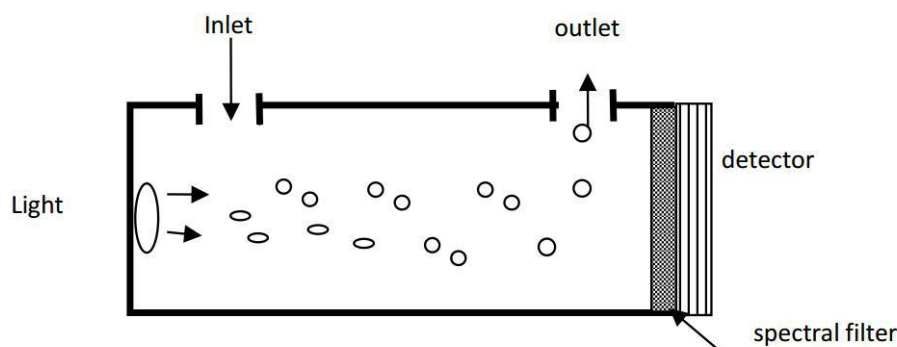
Basic mathematical model：A majority of both organic and inorganic polyatomic gas have specific absorptive wavelength in infrared region. When infrared light passed by, the light transmissivity of this gas molecule to certain wavelength can be expressed by Lambert-Beer Law:

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 Parameters

Configuration Table

Sensor Type	Gas	Concentration Range	Temperature or Humidity Compensation		Auto Baseline Calibration [2]	Sensor Dimension (mm)		QTY of Pins
			Temperature Sensor	Humidity Sensor[1]		Φ20*16.6	Φ20*19	
SRH-05	Carbon Dioxide	0～5000ppm	√	√	√	-	√	5
SRH-05XD		0～5000ppm	√	√	√	√	-	5
SRH-1		0~1%Vol	√	√	√	-	√	5
SRH-1XD		0~1%Vol	√	√	√	√	-	5
SRH-2		0~2%Vol	√	√	√	-	√	5
SRH-2XD		0~2%Vol	√	√	√	√	-	5
SRH-5		0~5%Vol	√	√	√	-	√	5
SRH-5XD		0~5%Vol	√	√	√	√	-	5
SRH-10		0~10%Vol	√	√	√	-	√	5
SRH-10XD		0~10%Vol	√	√	√	√	-	5
SRH-20		0~20%Vol	√	√	√	-	√	5
SRH-20XD		0~20%Vol	√	√	√	√	-	5
SJH-5	Methane	0~5%Vol	√	√	√	-	√	5
SJH-5XD		0~5%Vol	√	√	√	√	-	5
SJH-100		0~100%Vol	√	√	√	-	√	5
SJH-100XD		0~100%Vol	√	√	√	√	-	5
SBH-2	Propane	0~2%Vol	√	√	√	-	√	5
SBH-2XD		0~2%Vol	√	√	√	√	-	5
SBrH-5[3]	Methyl Bromide/ Bromomethane	0-5%Vol	√	-	√	-	√	5

1. 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.

2. ABC（Auto Baseline Calibration） is off as default, it could be activated by communication protocol.

3. SBrH-5 with humidity sensor can be customized.

Technical Specification

Sensor Type[4]	SRH-05 SRH-05XD	SRH-1 SRH-1XD	SRH-2 SRH-2XD	SRH-5 SRH-5XD	SRH-10 SRH-10XD	SRH-20 SRH-20XD	SJH-5 SJH-5XD	SJH-100 SJH-100XD	SBH-2 SBH-2XD	SBrH-5
Gas	Carbon Dioxide						Methane		Propane	Bromomethane
Measurement Range[5]	0～5000ppm	0～10000ppm	0~2%Vol	0~5%Vol	0~10%Vol	0~20%Vol	0~5%Vol	0~100%Vol	0~2%Vol	0-5%Vol
Accuracy[5,6]	≤±25ppm or 10% of reading, larger value as criteria		0～1%：≤±0.1%vol 1%～full range：≤± (0.05%+5% of reading)		0～1%：≤±0.1%vol 1%～5%：≤±(0.05%+5% of reading) 5%～full range:≤±10% of reading		0～1%：±0.06%vol 1～2.5%：±6% of Reading 2.5%～full range: ±6% of Reading		≤±0.1%vol	0-1%: ±0.06%Vol 1-5%: ±6% of reading
Resolution	1ppm		0.01%							
Warm-up Time[7]	<10s									<30s
Maximum Response Time (T$_{90}$)	<25s									
Zero Repeatability[8]	-						±0.01% Vol		±1%FS	±2%FS
Full Scale Point Repeatability[8]	-						±0.03% Vol		-	-
Zero Drift[7]	±1%FS						±0.01%vol/month		2%FS/Month	2%FS/Month
Working Temperature	-40～70℃									
Storage Temperature	-40～85℃									
Working Humidity[9]	0-95%RH (Non-condensing)									
Working Voltage	3.3～6.0VDC									
Working Current	55～60mA									
Working Pressure[10]	1. 30~130kPa 2. All data can be ensured at pressure 101 kPa									
Peak Current	360mA-400mA (5V Input)									
Output Type	UART-TTL (2.5-3.3V) /DA output (0.4-2V)									
Dimension	Refer to Configurations Table									
Body material	Stainless Steel									
Weight[11]	18g/15.6g									
Life Span[12]	>10 years									
Ex-proof Level	Ex ia IIC T4 Ga GYB19.1789									-

4. Sensor type with XD is the sensor with dimension Φ20 x 16.6mm (Except Pin), others is Φ20 x 19mm (Except Pin).

5. 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%.

6. Performance defined above is after calibration. All Cubic sensor have 100% calibration in production.

7. Ambient temperature (20°C)

8. After sensor stabilization and over a period of 8 hours and ambient temperature (20°C)

9. 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.

10. Sensors shall meet specification within a ±5% change in ambient pressure from the ambient pressure during calibration, Sensors can be used over a greater ambient pressure using pressure compensation of the concentration. An external pressure sensor will be required for this.
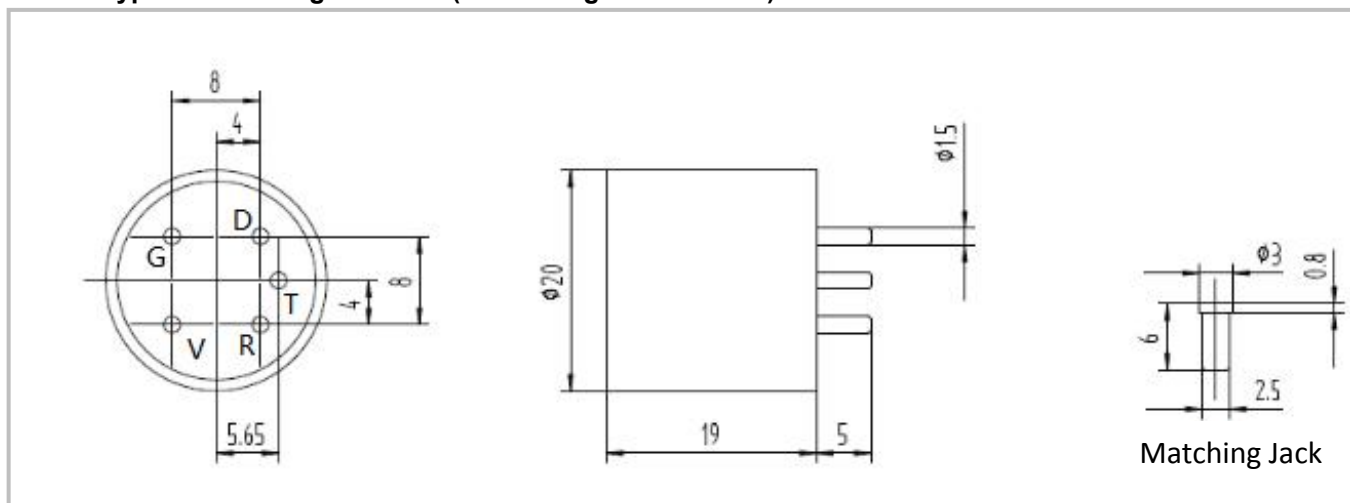
11. Weight of sensor type with XD is 15.6g; weight of sensor type without XD is 18g.
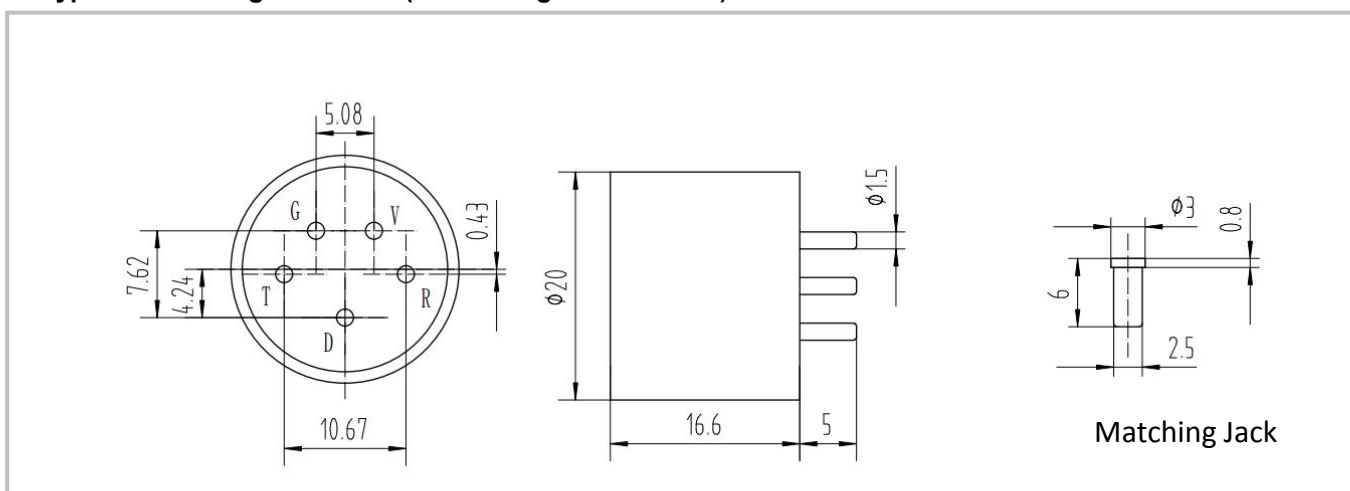
12. IR Source only and continuous working.

Configuration & Pin Definition

1. Appearance Size

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

Matching Jack

XD Type Sensor Height 16.6mm (See Configuration Table)

Matching Jack

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	Voltage 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.
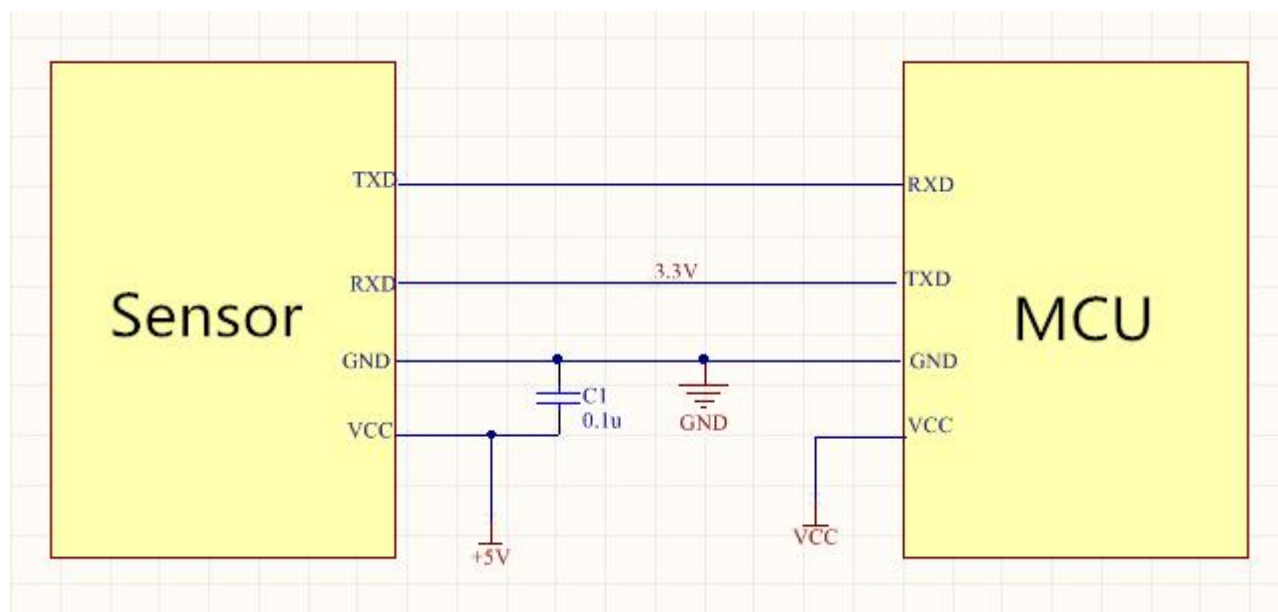
2. Body dimensional tolerances ±0.2 mm.

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
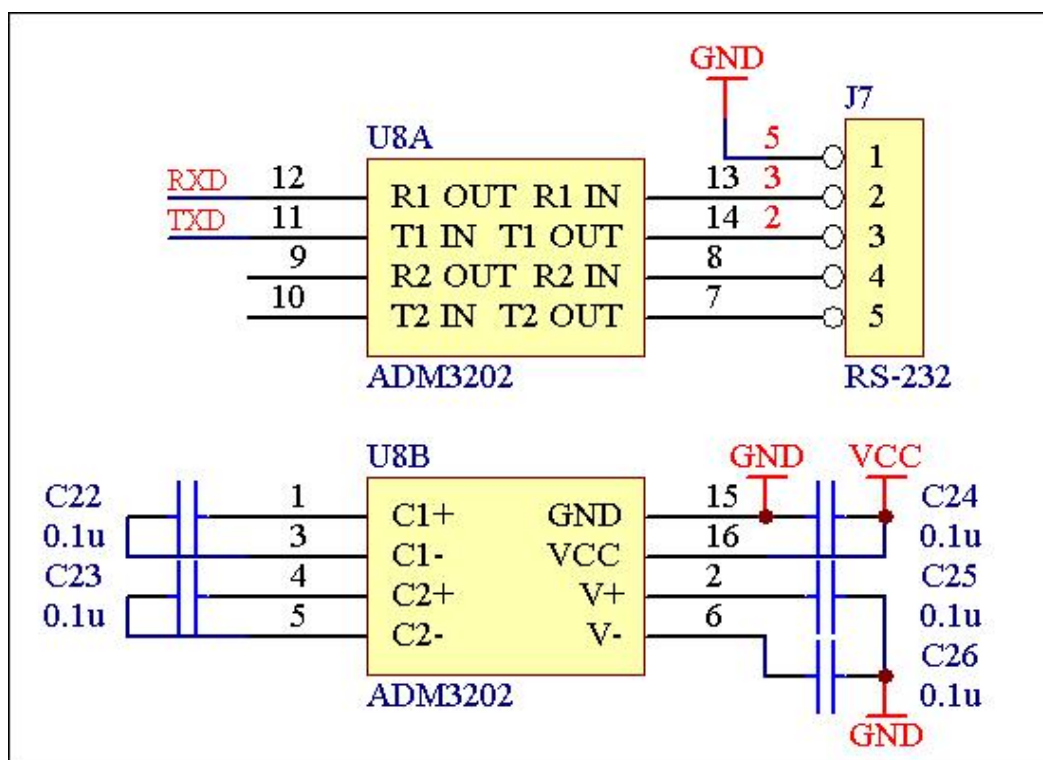
Application Scenario 2: UART-TTL to RS232

When connecting external circuit, computer circuit is illustrated below:

Baud Rate：9600bps

Data Bit：8

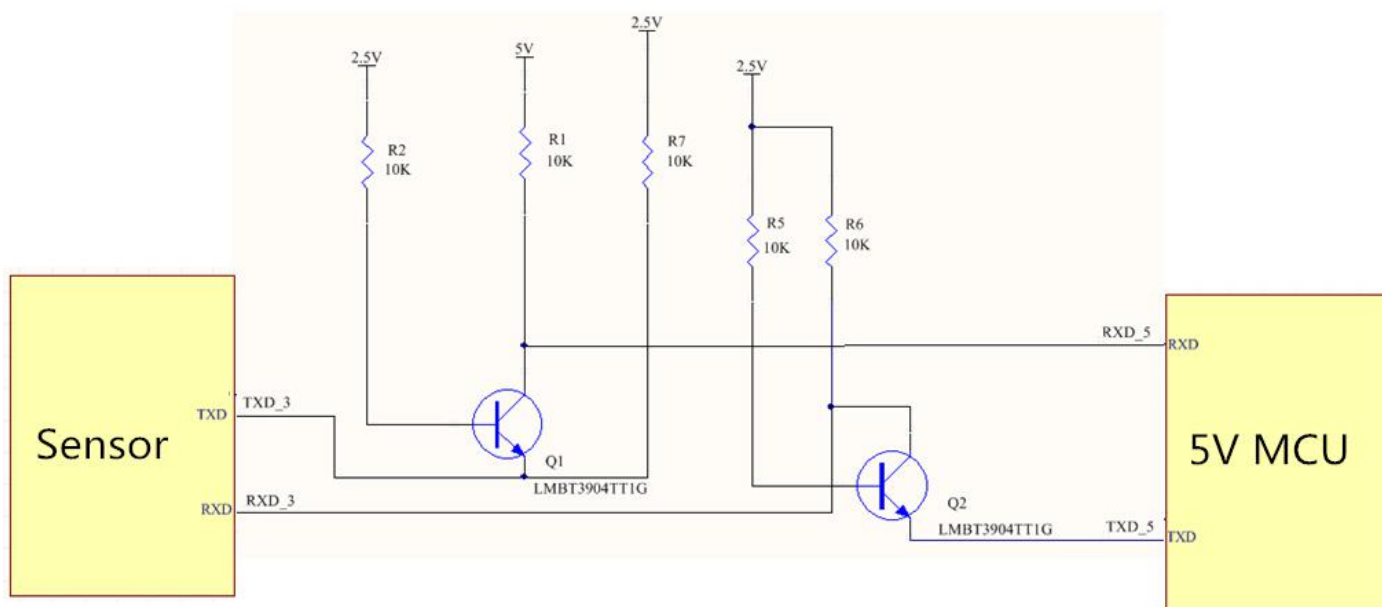Stop Bit：1

Check Bit：null

Picture 2: UART-TTL to RS232 Circuit

Typical Application Circuit Diagram

Application Scenario 3：5V-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 4：Voltage 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:
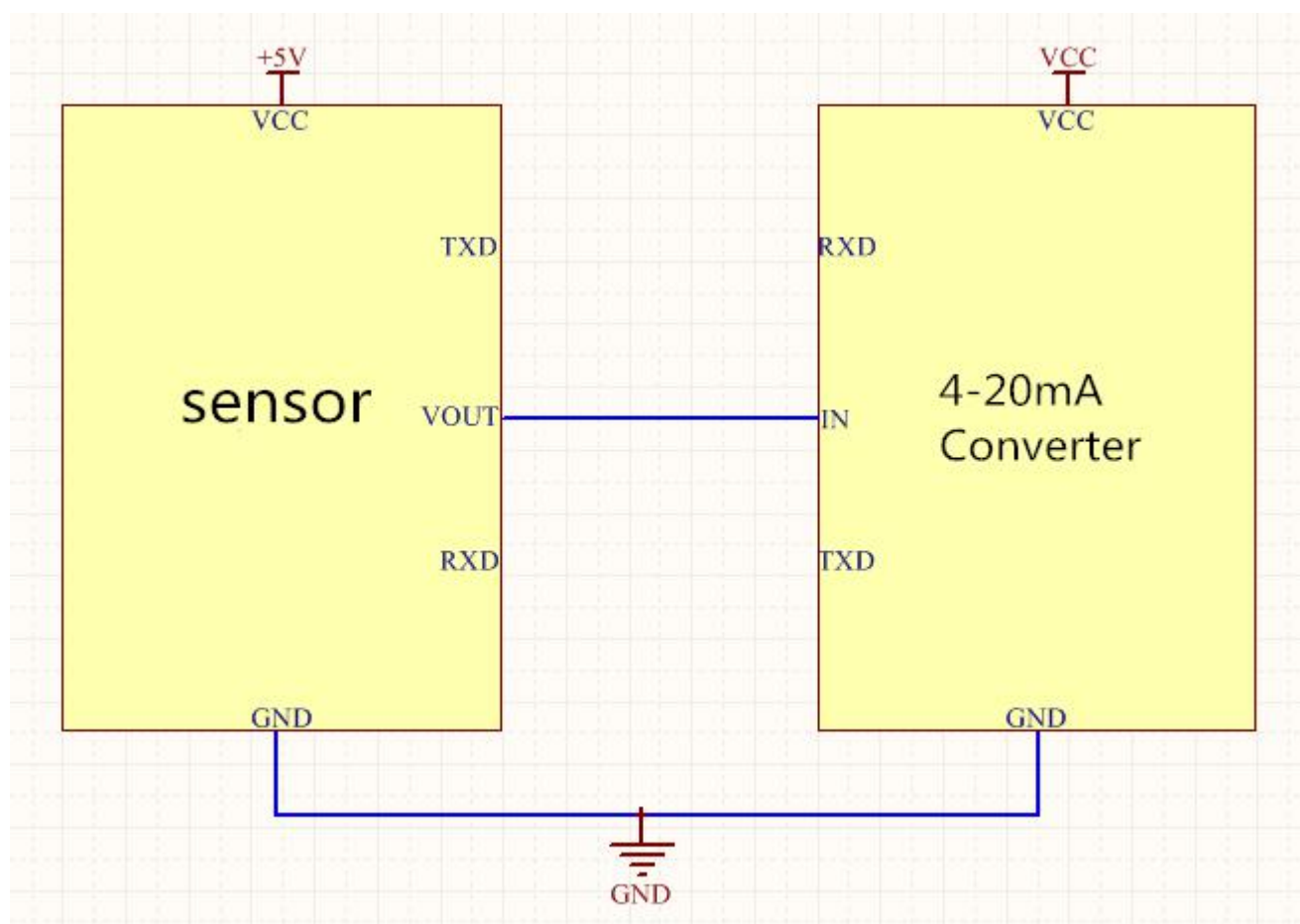
Picture 4: Analogue signal output circuit

Precautions for Use

1. Working temperature: - 40 ℃ ~ 70 ℃

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

3. 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.

4. 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.

Communication Protocol

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	Middle Point for User Calibration	0x4E	For 100% range only
3.3	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	Check and Set Auto Baseline Calibration Parameter	0x0F	

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)，

   For SRH-05&SRH-1, Gas 1 concentration=（DF1*256+ DF2）

2. [ST1] Sensor working status

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

Communication Protocol

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.

Communication Protocol

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 Middle Point for User Calibration (Same as Zero Adjustment) (4E)

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

Response：[ACK] 01 4E [CS]

Function：make middle point calibration for the gas

Remark: For 100% measurement range only.

3.3 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）or = (DF1 * 256 + DF2) for SRH-05&SRH-1.

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/three 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.

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.

Communication Protocol

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	$CH_4/C_3H_8/CBrH_3$
1	CO_2
2	
3	

Remark: 0 is based on sensor.

3   The definition of the unit is as following:

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

[DF5] [DF6] reserved

Communication Protocol

8. Check and Set Auto Baseline Calibration Parameter

[This protocol is only for SBH-2 type. For other sensors, this protocol could be added. Please contact with Cubic team by info@gassensor.com.cn]

8.1 Check Auto Baseline Calibration Parameter

Send: 11 01 0F DF

Response： [ACK] 07 0F [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [CS]

Function： to check sensor calibration parameter

Remark:

[DF1]: reserved; [DF2]: auto calibration open/close; [DF3]: calibration cycle; [DF4] & [DF5]: base value; [DF6], reserved.

DF Description

DF	Description
[DF1]	Reserved(0x00)
[DF2]	Auto calibration open/close, 0&1: open, 2: close
[DF3]	Calibration cycle (Days, 1-30 days optional)
[DF4] & [DF5]	Base value=[DF4] *256+[DF5], the base value is an integer, and the corresponding multiple is enlarged according to the decimal places. For example, when the decimal places are 2, the base value is 1.00%, so the base value here is 100 instead of 1.
[DF6]	Reserved(0x00)

8.2 Set Auto Baseline Calibration Parameter

Send: 11 07 10 [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [CS]

Response： 16 01 10 D9

Remark: [DF1]: reserved; [DF2]: open/close auto calibration; [DF3]: calibration cycle; [DF4] & [DF5]: base value; [DF6], reserved. DF description table above is for reference.

Example:

1. In sensor, the ABC function is off as default. If want to open it, should set DF2=00 or 01.

When ABC function is opened and want to close ABC function, should set DF2=02

2. If want to set a 7 days' auto calibration and the baseline is 0. The send command is [11 07 10 00 01 07 00 00 00 D0], when you get [16 01 10 D9], the auto calibration is set successfully.

After-sales Services and Consultancy

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